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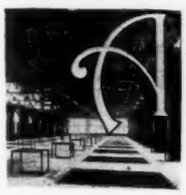
Agricultural Castings Made at Minimum Cost

A Modern Foundry at Moline, Ill., Which is Equipped With Special Molding, Melting, Casting and Sand-Handling Equipment

By J F Ervin*



N INDUSTRY confined to the production of a large number of similar and duplicate parts, such as are met with in the manufacture of agricultural implements, is forced through competition to operate at a minimum cost.

This necessity has prompted the manufacturer and engineer to attempt the solution of the problems involved, not only by efficient operation and scientific management, but through the application of the basic principles of modern plant and equipment design. Each section of the industry requires special study to discover its particular inherent conditions. The gray iron casting plays an important part in the design of agricultural implements and is in turn one of the paramount items of final cost.

An analysis of a gray iron foundry cost sheet shows that molding labor is one of the major items of expense. This item is not only the largest but it is the one which governs the plant production and the one on which nearly all other cost items are directly dependent. In the production of castings at a minimum cost, we must, therefore, furnish the molder with better conditions and equipment, and the opportunity to spend a greater part of the working day at making molds.

John Deere & Co., Moline, Ill, manufacturers of all classes of farm machinery, have erected and put in operation a modern two-story foundry at the harvester plant in East Moline. This plant is designed to ultimately produce 25,000 tons of castings per year of 250 working days. The management has taken full advantage of its resources in the design of this plant in order to gain a maximum output per man by the employment of modern ideas in building and equipment. The plans are also made to allow close subdivision of labor.

The methods adopted are significant of the Deere policy, which is to maintain the quality of the product at the highest practicable standard. This foundry makes only gray iron castings, such as are used on mowing machines, grain and corn binders,

*Foundry engineer with John Deere & Co.

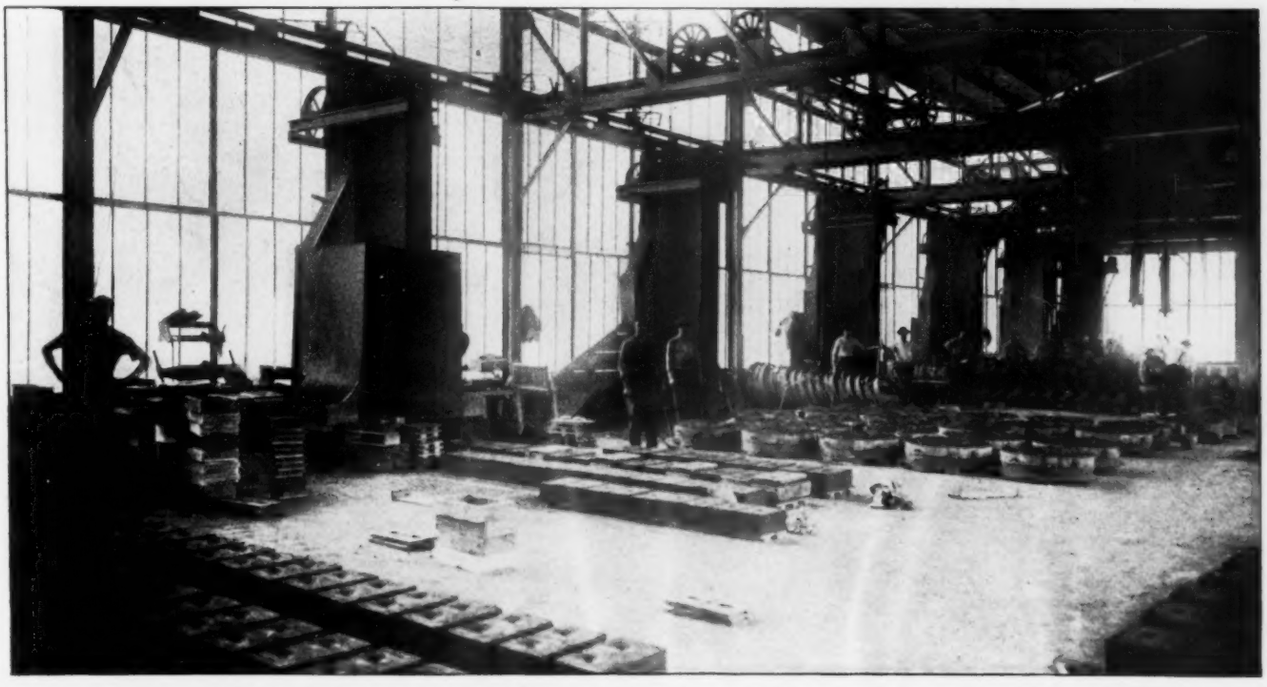


FIG. 1—SECTION OF MOLDING FLOOR SHOWING FOUNDRY IN OPERATION ON LIGHT AND HEAVY WORK

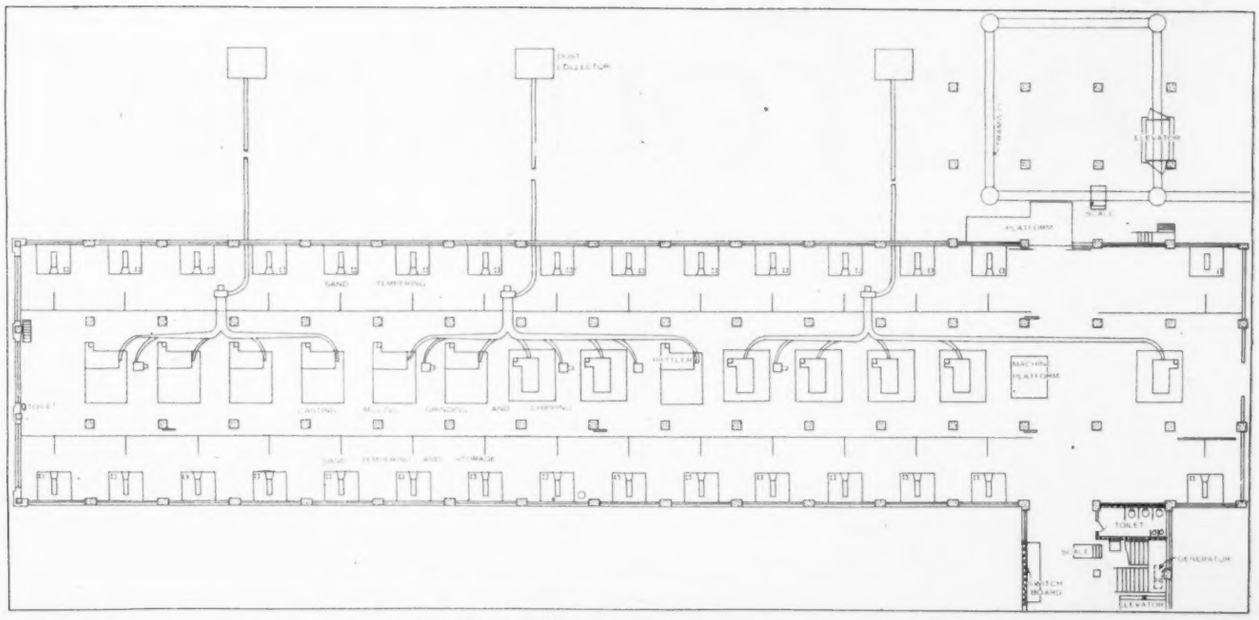


FIG. 2—LOWER FLOOR OF MAIN FOUNDRY BUILDING SHOWING SAND TEMPERING AND STORAGE AND CASTING CLEANING DEPARTMENTS

spreaders, plows and planters. The castings vary in weight from 200 pounds to a few ounces.

The natural course for cheap and rapid production is adhered to by having all operations follow in regular order, at the same time providing means of handling materials with the least effort. The unit system adopted affords great flexibility in operation and the minimum possibility of molding delays due to difficulties in the operation of equipment.

The foundry runs continuously and all operations are carried on uninterruptedly throughout the day. The working day is 10 hours, beginning at seven in the morning and quitting at 5:30 in the afternoon. One half hour is used for lunch.

Figs. 2, 3, 6 and 7 show a general plan of the buildings and grounds. The buildings are reinforced concrete, steel and glass. The molding and cupola buildings are beam construction while the service building is of the flat slab type.

The cupola building is 30 x 60 feet, three stories. The first floor is not enclosed. The second floor is on a level with the foundry molding floor and is covered with 4 inches of clay. A reinforced concrete mezzanine floor, 8 feet wide and 30 feet long, is supported 15 feet above the second floor by wall brackets from the foundry building columns. This floor supports one cupola blower and affords room for a second.

The third floor is the charging floor. It is 25 feet above the cupola floor and is built of structural steel covered with diamond rolled steel plates. The roof is single valley reverse pitch type and the span is 60 feet. The trusses are structural steel and are covered with flat tile and composition roofing.

The foundry building proper is two stories, 60 feet wide and planned for an ultimate length of 600 feet. The section now completed is 340 feet long.

The lower floor of this building is concrete and the second floor is reinforced concrete and steel beam construction. The roof trusses, which are steel spanning 60 feet, support cranes over the molding floors and a 2-ton monorail which runs on suspended beams in the center of the building. The roof is single valley reversed pitch and is covered with flat tile and com-

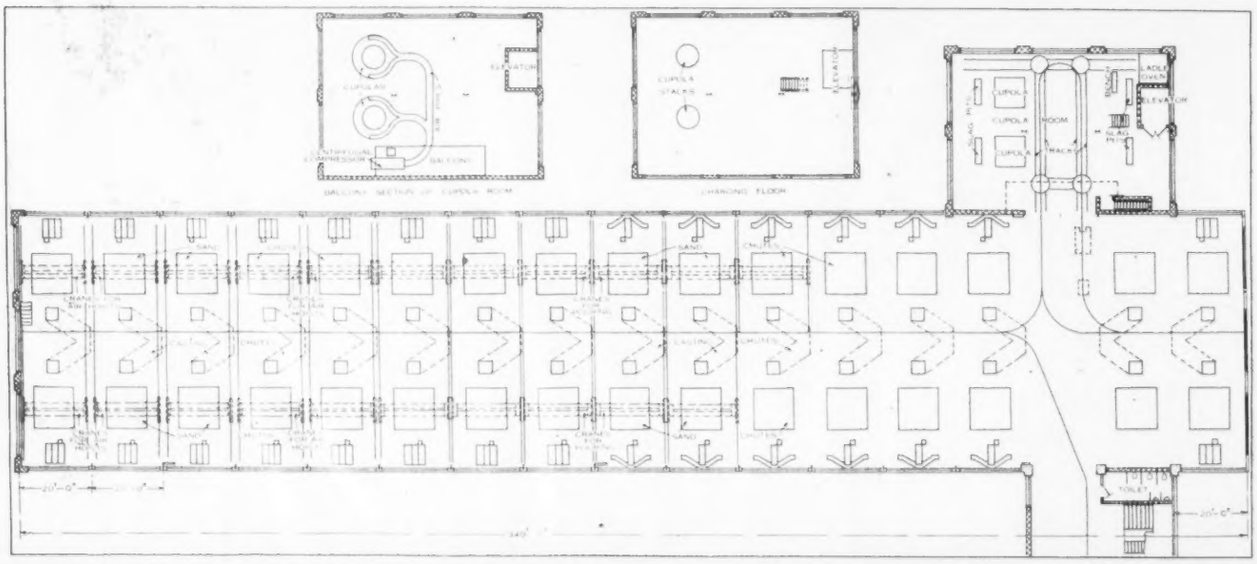


FIG. 3—MOLDING FLOOR, CUPOLA AND CHARGING FLOORS SHOWING GENERAL ARRANGEMENT OF MACHINERY

position roofing, similar to the cupola building.

The foundry building is paralleled by a service building of reinforced concrete and steel, 60 feet wide and 120 feet long. The first floor is level with the yard and the second floor is on the molding floor level. The roof is flat reinforced concrete, using cinders and composition roofing.

The service building is connected to the foundry by a reinforced concrete and steel building, 32 x 40 feet, two stories, with a pent house for the service elevator. This building affords an aisle 20 feet wide for trucking between the buildings and also contains the toilets, both up and down stairs, elevator shaft and stairways from first to second floors and the pent house. The first floor of the foundry building is used for sand tempering and cutting, milling castings, finishing and grinding. The second floor of this building is used for molding, pouring and shaking out. The first floor of the cupola building is used for yard scales and making up charges. The second floor is used for cupolas, ladles and ladle ovens, while the third floor is used for charging and loaded truck storage. In the service building the first floor is used for core sand mixing, machining and painting castings and also for pattern and machine storage. The second floor contains the office, core making, core baking, core storage and washrooms.

The area occupied by each of the above divisions of operation is as follows:

	Square feet.	Per cent of total.
Cupola Building, First Floor, 2,160 Sq. Ft.		
Scales and shop scrap storage.	1,370	2.0
Elevator shaft	70	0.11
Cupola drop	720	1.1
Cupola Building, Second Floor, 2,160 Sq. Ft.		
Stairway	100	0.15
Ladle oven and accessories	300	0.45
Elevator shaft	70	0.11
Two 90-inch shell cupolas and accessories	1,690	2.6
Cupola Building, Mezzanine Floor, 240 Sq. Ft.		
Two 7,200 cu. ft. blowers; G. E. centrifugal type. (Only one installed at present.)	240	0.37
Cupola Building, Third Floor, 2,160 Sq. Ft.		
Two 90-inch shell cupolas and truck storage	2,090	3.23
Elevator shaft	70	0.11
Foundry Building, First Floor, 20,400 Sq. Ft.		
Sand tempering storage and cutting	10,880	16.8
Milling, grinding and chipping	9,520	14.8

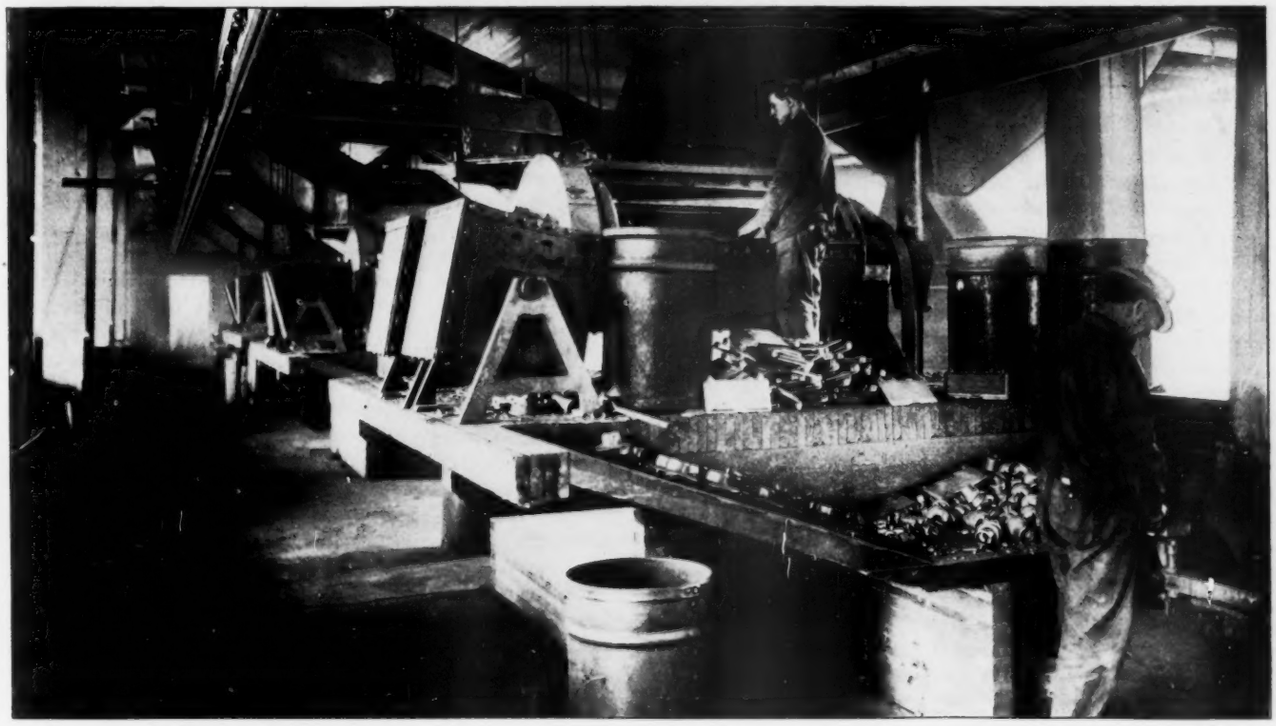


FIG. 4—MILLING AND GRINDING UNIT UNDER MOLDING FLOOR

Foundry Building, Second Floor, 20,400 Sq. Ft.		
64 molding floors, 250 square feet each	16,640	25.8
Aisles	3,760	5.8
Service Building, First Floor, 7,200 Sq. Ft.		
Core sand mixing	600	0.93
Machining and painting	3,600	5.5
Pattern and machine storage	2,400	3.7
Stairways and entrance	600	0.93
Foundry Service Connection, First Floor, 1,440 Sq. Ft.		
Aisles, scales, etc.	720	1.1
Elevator shafts, toilets and stairways	720	1.1
Foundry Service Connection, Second Floor, 1,440 Sq. Ft.		
Aisles	720	1.1
Elevator shafts, toilets and stairs	720	1.1

The total floor space including the machining department is 64,800 square feet, while the melting capacity is 70 tons per day with the present length of molding floor. The ratio of tons melted per day to floor space is 70 to 64,800, or 927 square feet per ton of daily output. This ratio will be greatly reduced when the molding building is extended, since the attending buildings are ample for the foundry 600 feet long. This extension will add 31,000 square feet of floor space and 60 tons to melting capacity. The ratio will then be 130 tons to 95,800 square feet, or 740 square feet per ton of output. The efficiency of this ratio may be noted by referring to the figures which appeared in the May, 1913, issue of THE FOUNDRY on production and areas of foundries producing similar castings.

The buildings are enclosed by factory rib glass and Lupton steel sash. The foundry and cupola buildings have counter balanced sash with a sill 30 inches above the floor. The second floor of the foundry building has two rows of hinged ventilating sash above counter balanced sash. The second and third floors of the cupola building are also fitted with hinged ventilating sash above the counter balanced type. The service building is enclosed above a 45-inch sill with glass and steel sash. These sashes are of the double pivotal type, having ventilators both at the top and bottom of glassed portions.

The plant is heated by the direct radiation steam vapor system. Cast iron wall radiators hung on wall brackets supply the molding floor and cupola rooms. The molding room is sup-

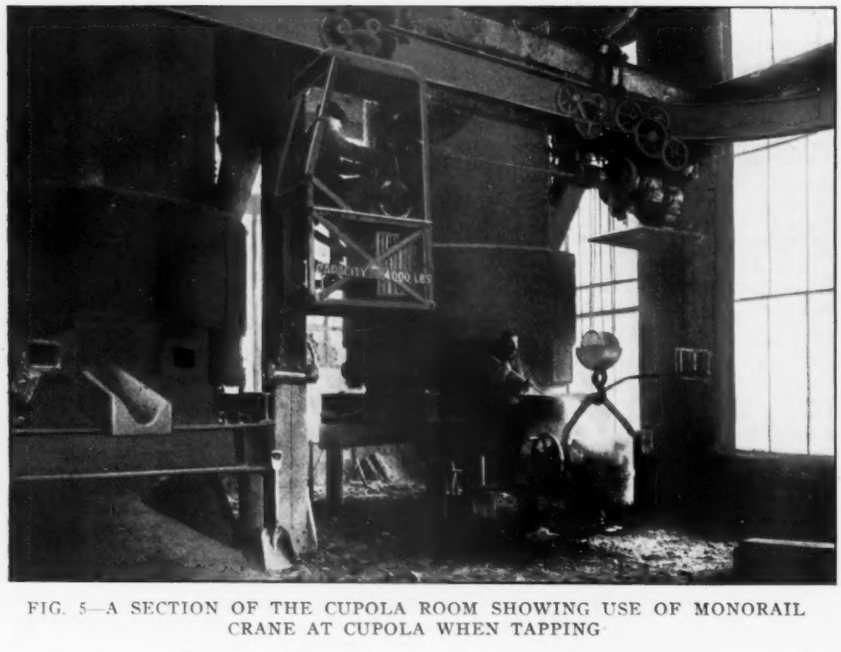


FIG. 5—A SECTION OF THE CUPOLA ROOM SHOWING USE OF MONORAIL CRANE AT CUPOLA WHEN TAPPING

plied with 13 square feet of radiation for 1,000 cubic feet of building contents, and the first floor of the building is heated from overhead pipe coils, which supply it with 16 square feet per 1,000 cubic feet of contents. The cupola building on the second floor is heated by cast iron wall radiators and has 9 square feet of radiation per 1,000 cubic feet of building contents, and the charging floor has 9 square feet per 1,000 cubic feet of building contents. The service building has overhead coils and is supplied with 13 square feet per 1,000 cubic feet of building contents. Steam is supplied from the boiler room at 125 pounds pressure and is regulated for the entire building by reducing valves to a maximum of one pound pressure.

The ventilation of the foundry building is natural through the two rows of hinged sash on each side of the building. All other parts of the building have no special ventilation except the core oven room, which is ventilated by four stacks 3 feet in diameter and 10 feet high, leading through the roof in the service building.

Illumination

The building is electric lighted. All wiring is laid in concrete with sherardized conduits. The general illumination of each department is as follows:

	Candle power per 100 sq. ft. of floor area.
Sand tempering	16
Casting, milling and grinding	16
Molding floor	33
Cupola room	30
Charging floor	16
Pattern room	50
Wash room	50
Oven room	50
Core storage	50
Machine room	50
Office	80
Core making	250

The power for lighting is supplied at 4,400 volts, alternating current, by the power company and transformed to 220 volts at the building. The connections are made for 110 volts across terminals. Control of the lighting is centered at the foundry service connection for each floor of the foundry and cupola buildings, while the control of the service building lights is located in the center of the building on each floor. Individual illumination is supplied to molders only and this is accomplished by a wall socket attached to columns between sand elevators and 5 feet above the floor. This furnishes a connection for an extension where deep jobbing molding is being done, otherwise a fixed 60-watt tungsten lamp supplies the illumination for two molders.

All of the machinery is electrically driven and power is purchased from the power company at 4,400 volts, two-phase 60-cycle. It is then transformed to 440 volts, three-phase, in which condition it is used in induction motors. The power wiring is laid in sherardized conduits set during the building construction. All the small motors are controlled by air brake switches suspended to the ceiling with hand chain operators. Main control of all power is made on panel board located on the wall of the service foundry connection. The power for the second floor is controlled on the second floor and for the first floor on the first floor. A motor-generator set is installed to generate 220-volts direct current for use on the electric mono-rail handling iron.

Water is supplied at each column in the sand-tempering department on the first floor and at each wall column between the molders on the second floor. Air at 80 pounds pressure is compressed by an electrically operated belted compressor located on the first floor of the service building. Connections are available for molding machines or hoists on each molding floor throughout the building. Gas is purchased from the city and piped to all floors where it is necessary to heat pattern plates or machines.

Unit System in Foundry

Each section of the foundry, consisting of two floors, 20 feet long and 60 feet wide, comprises one complete unit for producing castings ready for the machining room. This unit is

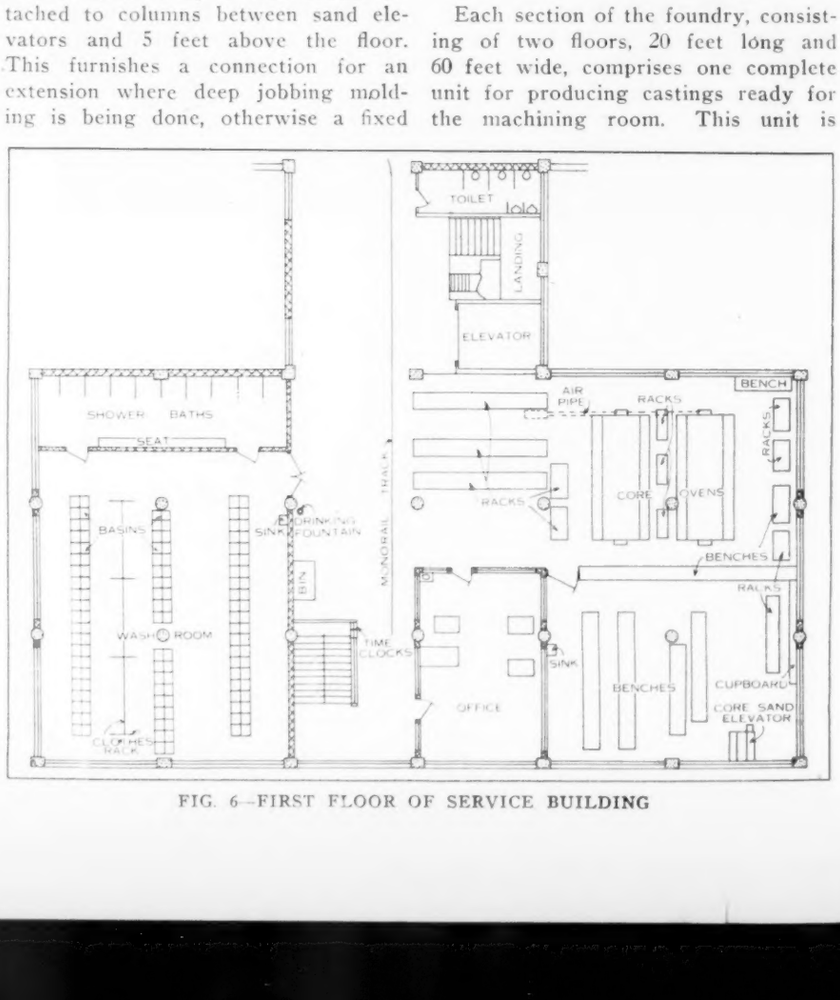


FIG. 6—FIRST FLOOR OF SERVICE BUILDING

quipped with two sand-handling systems, one casting storage reservoir, one tumbling mill, one emery wheel and one chipping bench. The unit is further equipped with two cranes, two air hoists and one extra tumbling mill, where heavy castings are produced on the floor. Each system supplies four molding floors on the upper floor with 260 square feet of floor space each, and one milling, grinding and chipping room of 560 square feet and two sand-tempering rooms with 320 square feet of floor space each on the lower floor.

Fig. 1 shows a general view of the molding floor in operation. Each unit, as stated above, consists of four molding floors, two of which are on each side of the building and each set of two is furnished with the sand handling system which consists of a grating in the floor 10 feet square and covered with cast iron checkered grates 30 inches square with 2-inch square openings. These grates, which take up 50 square feet of each molding floor, are supported by I-beams across the opening.

Directly under the grates is a deflecting chute built of sheet steel in the form of an inverted frustrum of a pyramid which extends 6 feet below the floor. The sides of this chute are inclined to the molding floor at an angle of 45 degrees, which allows the sand to flow freely when it is dumped through the grates for the molders. Directly below this deflective hopper is a wooden partition which separates the tempering room from the milling and grinding room on the first floor. This partition is connected by another partition at right angles to it directly under the hopper upon which is mounted an oscillating gate. In front of this partition and toward the outside of the building is a chain bucket elevator used for returning the sand to the second floor.

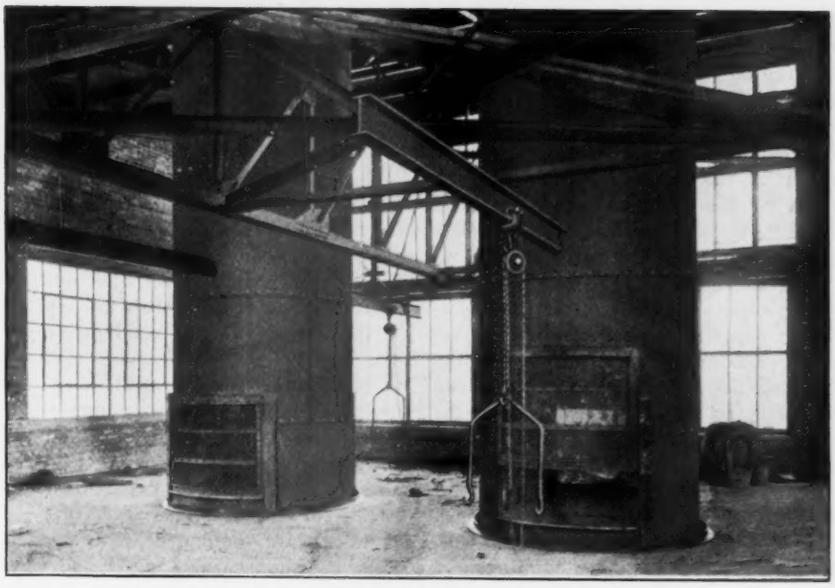


FIG. 8—CHARGING FLOOR

The boot of this elevator is set in a pit and is built in connection with a sand cutting and mixing device which is directly connected to a five-horsepower induction motor. This elevator extends to a level with the lower chord of the roof trusses which is 15 feet above the second floor. The elevator is fitted with an oscillating gate or deflector at the discharge which is toward the wall of the building. This deflector throws the sand to either side of the elevator, which is fitted with a sand storage which holds 1¾ yards of sand. The bottom of this hopper is fitted with a wooden shoveling board 18 inches from the floor, and extending 18 inches beyond the hopper. Fig. 1 gives general view of this construction.

The chain bucket elevator is driven by a three-horsepower induction motor supported by the elevator casing, and has a capacity of 1 yard of molding sand every six minutes. This allows the sand to be supplied to each pair of molders in a period which is a small part of the total day and also furnishes the additional advantage of tempering or soaking after mixing and elevating. A duplicate of this system is located on the opposite side of the building as shown in Fig. 1.

The system of handling castings is planned with one unit for two sand systems or one unit for four molding floors. It consists of two openings in the floor located midway between and at the rear end of each two molding floors. These openings are 10 feet apart, which leaves the main aisle of the building clear. Openings are lined with cast iron thimbles embedded in the concrete and are 3 feet square covered with a loose 2-inch plank top. These openings are connected to the cast iron chutes inclined downward at an angle of 25 degrees with the foundry floor and inward at an angle of 30 degrees.

At the converging point, a horizontal landing table is constructed. This landing table is fitted with a grating bottom which allows all loose sand to be collected and returned to the sand heap instead of going into the mill and wasted. Below and in front of the landing table is located a motor-driven steel plate tumbling mill, 30 inches in diameter and 60 inches

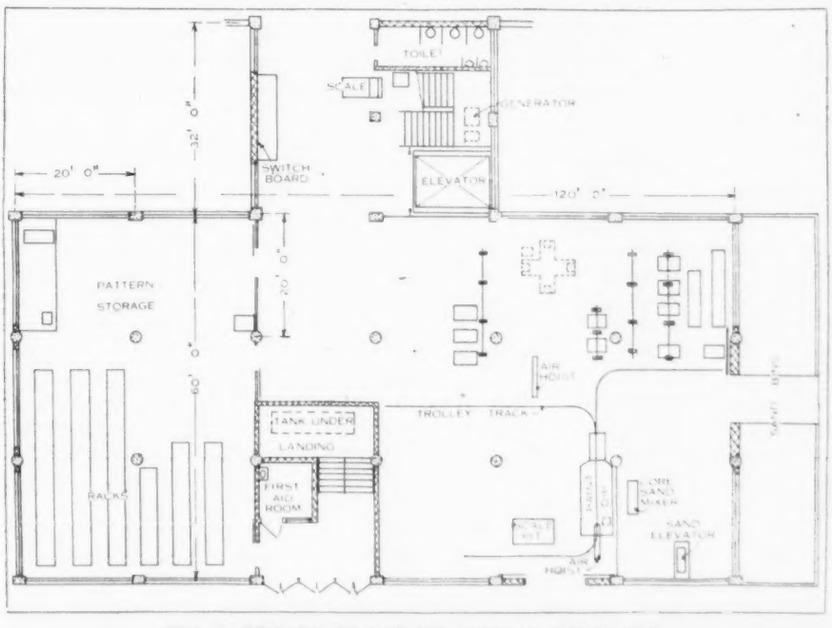


FIG. 7—SECOND FLOOR OF SERVICE BUILDING

long. This mill is direct connected to a 5-horsepower induction motor and is located on a platform 3 feet 6 inches above the floor.

The platform is fitted with dumping buckets and barrels, with a receiving basin at the front end. Directly in front of the platform is a single end roller bearing motor-driven grinder of special design. The chutes or inclines are designed and used as casting cooling reservoirs and have sufficient capacity to accommodate a five-hour maximum production of the molding floors. They are also placed at such an angle as to allow the castings to slide easily but to avoid breakage due to impact.

How the System Works

The molder's machine faces the window or outside of the building and the molder shovels his sand into the mold from the shoveling board. One man shovels from the right hand and one from the left hand. He then sets his molds on the floor, and pours the iron delivered to him. The molds are shaken out on the grid, the sand goes to the first floor and the hot castings remain on top. The hot castings and gates are raked into the casting reservoir and the floor is again ready for operation.

The sand passes through the deflecting hopper and strikes the oscillating gate which throws it to one side of the lower fence partition, as shown in Fig. 12. This partition allows the hot sand to be shaken out at all hours without interfering with the cooled and tempered sand on the other side of the fence.

The sand is wet down and opened up by the men on the sand tempering floor, and is shoveled to the elevator and mixer when it is cooled and properly tempered. A large quantity of sand is kept in the system which keeps it cool and properly tempered at all times. The new sand is put into the system by dumping it into a heap on the first floor.

The castings, gates and sprues are retained in the cooling reservoir and pulled into the mill with a rake or hook when cooled. They are then milled and sorted from the mill to sorting buckets. The gates and sprues are thrown into a truck standing alongside of the platform. The castings to be ground are dumped onto the grinding platform from dumping buckets, after which they are ground and thrown into barrels for delivery to the storage or machining departments.

Half of the casting reservoirs or chutes are equipped with extensions as shown in Fig. 12, so that the larger castings, such as mower wheels, mower frames and binder frames, may be handled on the first floor level. The extension is made of cast iron connected to a landing platform on the chute and is inclined at an angle of 23 degrees to the horizontal. It is 7 feet wide and extends to within 3 feet of the floor. This arrangement affords a much larger storage space for the more bulky and larger castings and also supplies more room around the mills which are set along one side of the milling room.

The larger castings are milled in steel plate tumbling mills, 40 inches in diameter and 60 inches long, driven by 7½-horsepower induction motors. Each unit of four heavy work molding floors is equipped with two mills of this type.

The molding floor for large work, such as mower frames, is equipped the same as those for small work minus the sand reservoir on the sides of the elevators. In this case the sand is thrown directly on the floor against the elevator and a wooden fence along the wall. The sand, therefore, lies in a large heap from which it is shoveled into the molds. All molding floors for this type of work are fitted with bridge cranes, spanning between trusses and operating parallel to them.

These cranes are of special design with ball bearings and pressed steel wheels to insure lightness and ease of operation. Each crane is fitted with 8-inch balance type air hoists with 3-foot lift, supported by a roller bearing trolley operating on the crane I-beam. No hand control chains are used. The movement is gained by pushing or pulling the load in the desired direction.

In the molding process for this class of work, a drop plate machine is operated with the cope on one side of the elevator and the drag on the other with two or more men on each half of the pattern. When the double molding floor is filled, the molding machines are transferred on cranes to opposite sides of the building while the molds are poured, castings shaken out and put down the chute. This is necessary since the foundry is not yet operating to capacity and the floor space is not sufficient to accommodate production until the iron is delivered to the floor. When the capacity is enough to allow the cupolas to be operated full time, all the operations will be carried on continuously.

The exhaust from the tumbling mills is handled by small unit systems. Each unit is designed to take care of the exhaust from five casting cleaning sections or 20 molding

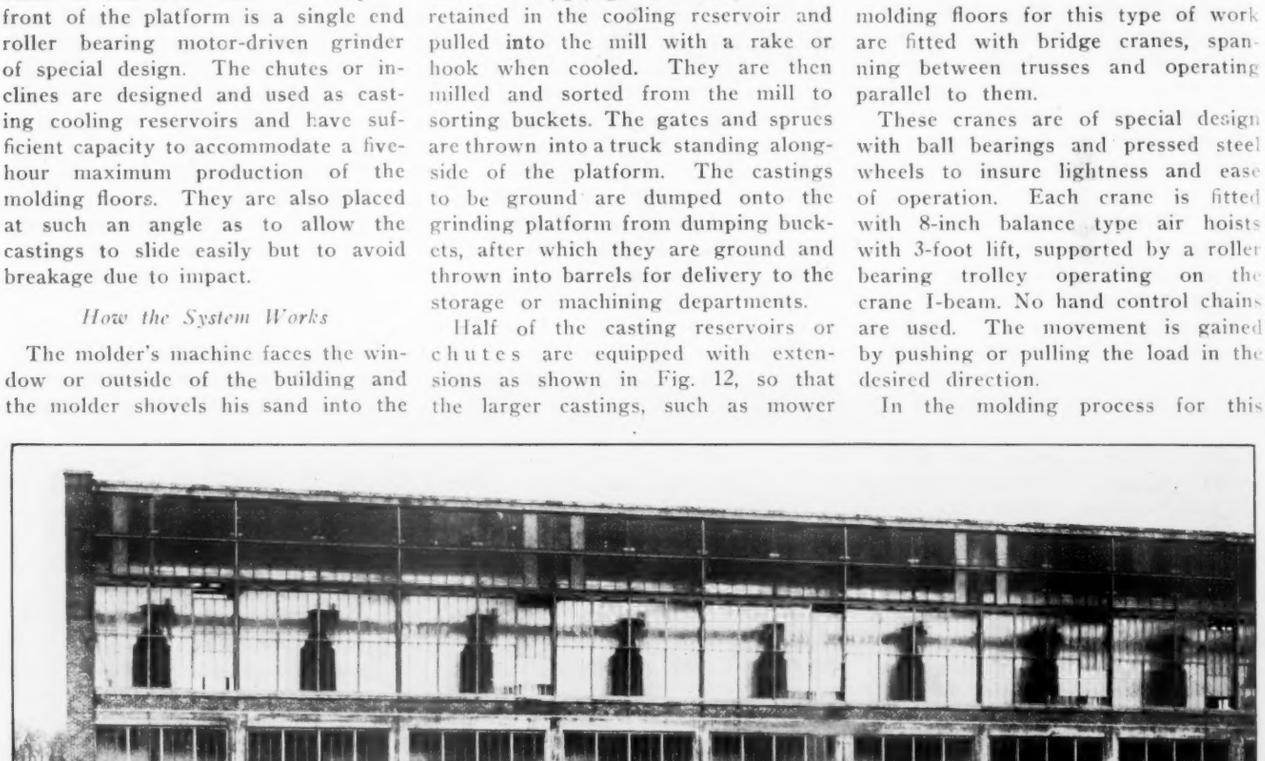


FIG. 9—ONE SIDE OF FOUNDRY BUILDING SHOWING LARGE AMOUNT OF NATURAL LIGHT DUE TO REVERSE PITCHED ROOF. THE SAND BINS MAY BE SEEN PLAINLY THROUGH THE WINDOWS.

floors. It consists of suction piping connected to tumbling barrels and to a No. 3 Sirocco blower, which discharges into a dust reservoir located 80 feet from the foundry building.

The blower is direct connected to a five-horsepower induction motor and handles all dust-laden air directly through the wheel. The dust receiver is a large sheet metal box with overhanging hood and two discharge spouts leading from the bottom. Connection is also made by the same system to the grinding wheels located at the tumbling barrel installations.

The room is kept remarkably clean since the air is changed in the cleaning, grinding and chipping departments every seven minutes.

The grinding work is handled by machines located at each mill installation. Each machine consists of a length of the cleaning room with a switch and stub running into each unit. The track also extends into the machining room. All large castings are hung on hooks and pushed to the machines for finishing, after which they are hung again and passed over the paint dip where a priming coat is given to them. The castings then are taken to storage.

All small castings are handled from the cleaning room in steel barrels, 28 inches high and 18 inches in diameter. When the castings are taken to storage they are dumped from barrels into a bin and when taken direct to the drill or erecting room they remain in the barrels until used.

The following types of molding machines are used: Power squeezers, power jolt squeezers, drop plate and roll over. The large quantities in

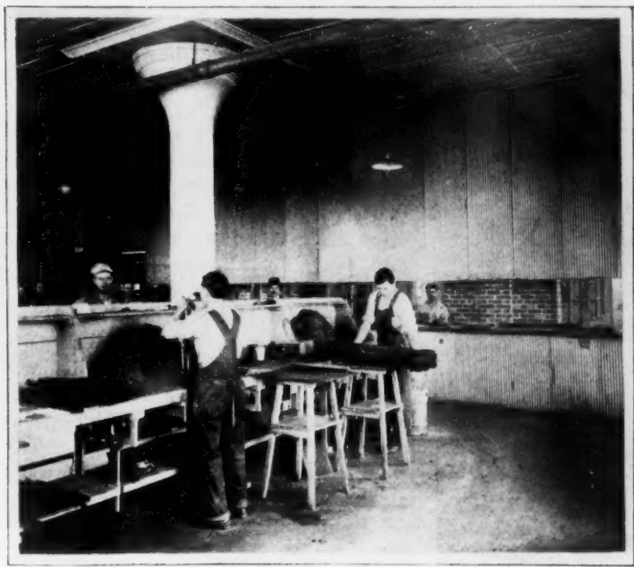


FIG. 10—A SECTION OF THE CORE ROOM SHOWING OVENS BEYOND PARTITION

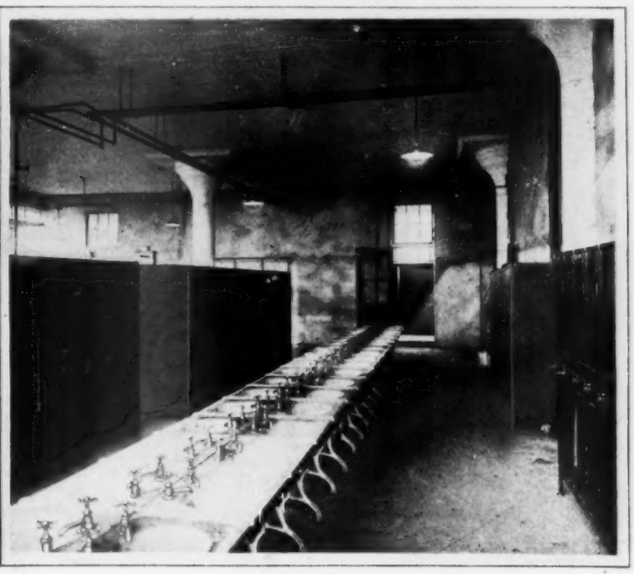


FIG. 11—WASH, LOCKER AND SHOWER ROOMS

shaft supported in a housing by Timken bearings with the grinding wheel on one end and an induction motor on the other. The motors are of the constant speed type and are operated in steps of 1,800, 1,200 and 900 revolutions per minute. The wheels are initially 24 inches in diameter and are placed on the 900 revolutions per minute machines. When they are worn to 18 inches diameter, they are placed on the 1,200 revolutions per minute machines, and when 12 inches they are transferred to the 1,800 revolutions per minute machines. This arrangement allows the wheels to be operated at all times at an efficient cutting speed. The wheels used are of the silicon-carbide type and vary in thickness from 3 inches to ¾-inch, Nos. 16 to 24 grain. Two-inch wheels are used for the greater part of the work. A trolley track extends the entire

which parts are manufactured allow special equipment to be economically supplied on almost all parts. Most of the larger parts are mounted on drop plates and hand rammed, while the smaller gated patterns and double face matches are used almost invariably on light power squeezers designed and built by Deere & Co.

All of the larger parts are made in cast iron flasks and a number of smaller parts are made in similar flasks of special design. The squeezer and bench work is almost all made in wooden snap flasks. Wooden bottom boards are used throughout. Cast iron adjustable jackets are being used quite successfully to replace the wooden jackets used prior to this time.

Fig. 5 shows the cupolas which have 90-inch shells. They were designed by the Whiting Foundry Equipment Co., Harvey, Ill. They are installed to melt continuously for a 10-hour day and produce 70 tons per day with the present lining, which is 21 inches, and 130 tons per day with a 12-inch lining. The foundry is now operating 45 tons a day and the continuous melting is accomplished by operating one cupola in the morning and one in the afternoon.

Air Supply

The air is furnished by a General Electric blower designed to deliver 7,200 cubic feet of free air at 16 ounces pressure. This blower is driven by a 50-horsepower, 440-volt, 60-cycle motor. The air is drawn from the outside and the supply is regulated on the intake side of the blower by a butterfly valve. This valve is fitted to be operated from the tapping floor by hand cables. The air is carried to the cupolas by a 20-inch galvanized iron pipe which branches into a Y and is discharged into the top of the wind box on the opposite sides of the cupola.

The inlets from the main line to each cupola are fitted with gate valves which allow the cupolas to be operated alternately. The blower discharge pipe is fitted with a blast meter which was furnished by Chas. T. Clark, 1214 West Monroe street, Chicago, and the cupola also is fitted with a mercury gage.

The iron is retained in the cupola bottom and tapped at intervals into a one-ton worm-geared ladle. This ladle is carried to the molding floors by a monorail crane. The rail is suspended from the roof trusses 2 feet off the center of the foundry building. It enters the cupola building in front

of the cupolas. The monorail carries the ladle to the foundry building where it is set in a ladle truck. The craneman then picks up an empty ladle from one of the other trucks on the floor and returns to the cupola for another charge. The trucks are spaced one every 60 feet. The iron is carried from the trucks and poured into the molds by hand. Two hundred pound ladles handled by two men are used for large work and the small work is poured from 50-pound ladles.

All the small, or snap work, is at present poured by the molder, while the larger molds are poured by a separate crew. Pouring devices are now being installed for a larger per cent of the work.

Fig. 10 shows the core room, oven room, with the core storage in the distance. The core room is equipped with benches for 22 core makers and has a lower bench on which core boxes and dryers may be placed.

The core boxes are stored in the core room on shelves under the window and are enclosed by rolling doors. The core wires are stored in a pigeon-holed box above the wall of the core room.

A galvanized iron partition separates the core-making room from the oven room. This partition has an opening provided with a shelf for setting plates with green cores. The green cores are delivered to this shelf by the maker.

The oven room is located beyond this partition and occupies 30 x 40 feet. It has a 12-foot ceiling and a flat concrete roof. This room is provided with four 3-foot stacks extending 10 feet above the roof, with natural ventilation.

The core storage occupies a space

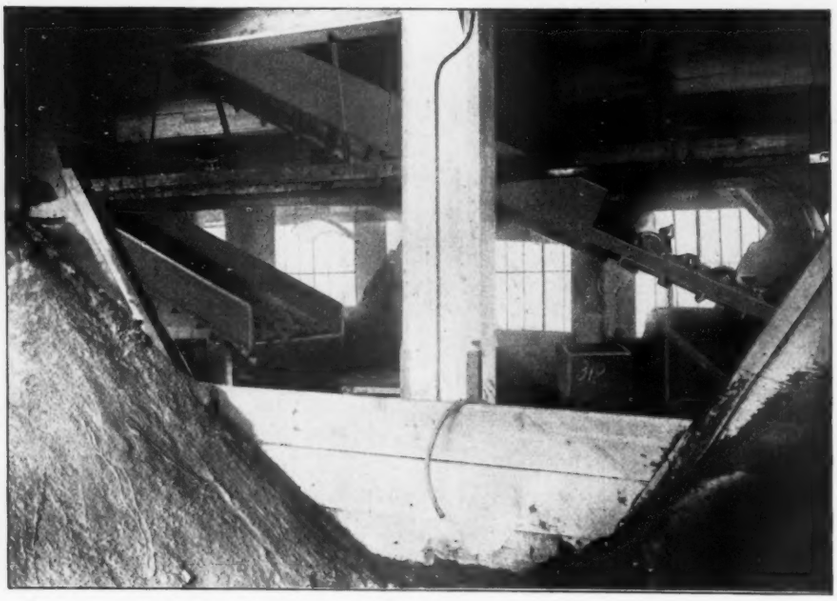


FIG. 12—SAND STORAGE BINS AND CASTING CHUTES

affords space for 25. The total space occupied by 22 core makers is 900 square feet. The benches are set back to back and are built with standard cast iron legs with a ⅜-inch steel plate cover over 3-inch oak on the table. The benches are 35 inches high and 48 inches long. Space for four core makers is allowed 72 inches long to take care of the larger work. Each bench is fitted with a shelf 18 inches high and 8 inches wide. Underneath the bench is a shelf for holding core boxes and dryers. This bench or shelf is 18 inches wide with a back 4 inches high. Each bench is provided with a stand 37 inches high and 18 inches square on which the core plates are set for placing cores. This was found necessary on account of there being more or less jar to the bench while making cores. This stand 20 x 30 feet and joins the oven room and main aisle to the foundry. It is provided with pressed steel racks. The latter are 30 inches wide and each section is 36 inches long. The corner angles are punched every 2¼ inches which allows the shelves to be placed in any multiple of this dimension. The shelf is made of No. 16 steel and will support a load of 175 pounds per square foot. This core storage has 1,600 square feet of core rack space. The small cores are stored in sheet steel decking boxes, in which they are carried to the molding floor by the molder, while the larger cores are delivered to the molder on a hand spike carried by two men. The boxes used for storing small cores are 3½ inches high, 9 inches wide and 36 inches long fitted with a handle on each end.

The core ovens are shown in part in Fig. 10. They are designed especially for fuel oil and each one occupies a floor space of 120 square feet. Each oven consists of five horizontal sections and each section has six shelves which furnish a total of 420 square feet of baking area, or two ovens furnish an area of 840 square feet. The shelves are spaced with shelve openings from the bottom to the top, as follows: Six inches, 6 inches, 12 inches, 6 inches, 6 inches and 12 inches, respectively.

The core sand mixing department is located on the ground floor directly under the first floor of the core room. It is equipped with a standard core sand mixing machine and binder storage. It also has a chain bucket elevator leading to the core-making floor. Sharp silica bank core sand mixed with molding sand is used. Two mixtures are made up using foundry linseed oil and glutrin. This sand is delivered direct from the mixer to the elevator which discharges into two bins along the sides of the elevator.

Fig. 11 shows a section of the washroom which is fitted with pressed steel lockers and wash basins for each employe. The shower room shown at the far end is typical of the equipment furnished in all of the Deere factories. This room is supplied with hot and cold water and at all times gives the employe the impression of neatness and cleanliness which is paramount throughout the shop. The completeness of the installation is emphasized by the fully equipped first aid room and first aid accessories located on the first floor of the service building.

Use of Manganese Ore

The Burr Co., Champaign, Ill., is using ground manganese ore in its gray iron foundry in making semi-steel. The ore is used in comparatively small pieces and the effect on the semi-steel is said to be practically the same as when using ferro-manganese. The pieces average 1 inch in diameter. The ore analyzes approximately as follows: 6.50 per cent silicon, 5.45 per cent iron, 51.45 per cent manganese and 0.09 per cent phosphorus. Allowances on account of the low manganese content of the ore as compared with ferro-manganese must be made in charging the material.

The Electric Controller & Mfg. Co., Cleveland, announces the appointment of the O. H. Davidson Equipment Co., Ideal building, Denver, as its representative in Colorado, Utah, Montana, Wyoming, South Dakota, New Mexico and Arizona.

How to Increase the Output of Your Foundry

What Continuous Operations Mean in Economies Effected and How You Can Produce at a Lower Cost

By G K Hooper

LIKE every other manufacturing establishment, a foundry is a device for making money out of labor; therefore, in designing such a plant, every means should be embodied to enable the laborers, whether skilled or unskilled, to do the utmost useful work which they are reasonably able to perform, having in mind their bodily, mental and social necessities.

In the early beginning of the foundry business so little information was available concerning its fundamental sciences of metallurgy, practical geology and the hydrodynamics of molten metal that skill in an operative, was largely a matter of intuition or genius. The trade, therefore, being built upon this, has not adapted itself as freely as possible to the sub-division of labor and use of mechanical appliances as have other trades, and the productiveness of the labor in it has not advanced rapidly. The processes, also, under this condition have a tendency to be wasteful in time and space.

In the foundry where no sub-division of labor is used, this productiveness averages, according to studies which I have made, from 50 to 60 per cent. With the sub-division of labor and the use of mechanical appliances and power, it rises to about 75 per cent.

With well arranged machine tools in the machinist trade, we are advised that the productivity of the labor has risen as high as 80 per cent, and on some classes of work to a higher figure.

What Adam Smith Said

As there are yet a number of foundry executives who believe that it is unwise, if not impossible, to use machinery and divide their labor, or, in other words, to use what is known as the gang system, I would like to quote what Adam Smith, the first great expounder of economics, says about sub-division of labor in his work known as "The Wealth of Nations", written about 1755. He speaks as follows:

The greatest improvement in the productive powers of labor and the greater part of the skill, dexterity and judgment with which it is anywhere directed or applied seems to have been the effects of the division of labor.

The great increase in the quantity of work which in consequence of the division of labor the same number of people are capable of performing, is owing to three different circumstances—

First.—The increase of dexterity in every particular workman.

Second. — To the saving of time which is commonly lost in passing from one species of work to another, and

Third.—To the invention of a great number of machines which facilitate and abridge labor and enable one man to do the work of many.

It is the great multiplication of the production of all of the different arts in consequence of the division of labor which occasion in a well-governed society that universal opulence which extends itself to the lowest ranks of people. Every workman has a great quantity of his own work to dispose of beyond what he himself has occasion for and every other workman being exactly in the same situation, he is enabled to exchange a great quantity of his own goods for a great quantity, or, what comes to the same thing, for the price of a great quantity of theirs. He supplies them abundantly with what they have occasion for and they accommodate him as amply with what he has occasion for and a general plenty diffuses itself through all the different ranks of society.

This sounds something like a treatise on the evils of restricting output. Mr. Smith gives also some statistics concerning results of sub-division in the pin and nail-making industries, generally as follows: With pins, one man by hand could make but about 20 per day, or 10 men could make 200 per day; whereas, by sub-division of the 18 different operations and with indifferent machinery, 10 men do make about 48,000 per day.

With nails he reports:

A blacksmith who has been accustomed to make nails can seldom, with his utmost diligence, make over 800 to 1,000 nails per day. I have seen several boys under 20 years of age who had never exercised any other trade but that of making nails, and who when they exerted themselves could make, each of them, upwards of 2,300 nails per day, the same person blowing the bellows, stirring and minding the fire, heating the iron and forging every part of the nail, being also obliged to change his tools in forging the head.

We might conjecture from the foregoing that there were scientific management and efficiency experts, even as early as 1750, and that achievement in the efficiency profession has fallen off since that time as no such percentages of improvement as the above figures entail, are offered us today.

With the better technical understanding which now exists concerning the underlying sciences of the foundry trade, there is more and more application of engineering talent to the investigation of the problems which arise. It is also as much a matter of engineering to find out what the human machine can be reasonably expected to perform as it is to properly judge the fitness of any mechanical device for foundry operation.

In foundry design, quite as much as in any other occupation, the quantity, quality and form of the product establish the limits within which a design must be contained in order to reach that most desirable situation, the providing for improvement of plant and equipment and the obtaining of substantial net profits.

Application of Labor to Product

The application of labor to the product is the next consideration. If skilled labor is necessary, means must be used to apply the skill only to those operations in which it is needed, sub-division of labor and the use of mechanical appliances and power being embodied wherever this can be profitably done.

In the molding and casting operations a considerable number of foundries today do sub-divide the labor on their product and employ separate labor gangs for pouring, shifting and shaking-out, sand-handling and core-setting. Some objection is made to this practice but, as you have just heard, it is sound economics to subdivide the labor, when the amount of product warrants it and an increase of skill may reasonably be expected to result, giving an increased production with corresponding reduction of cost.

Some confusion may arise at the commencement of such a method of operation, but this can be minimized

Presented at a meeting of the Newark (N. J.) Foundrymen's Association.

by using the most skillful and intelligent operatives as gang bosses.

To do away with the laborious part of lifting and transporting materials, there is the industrial railway with or without locomotive, the overhead monorail trolley track, either with or without power-driven traveling hoist, the air hoist, the jib crane, traveling wall crane and overhead traveling crane which covers nearly the entire floor area. Combinations of these are frequently used.

Molding Machines

For molding, molding machines of one kind or another, from the simple hand squeezer and the pneumatic hand rammer to the more elaborate power-ramming, pattern-drawing, rock-over type are available, each well adapted to some particular purpose. The molding machine is employed to advantage on a great variety of product and more and more uses are found for it every day. You are, however, all familiar with mistakes which have been made in the wrongful selection of molding machinery for any given work resulting in confusion as to the merits of such devices, and in loss. The general proposition still exists, however, that molding machinery properly adaptable to the work will increase profitably the productiveness of the laborer.

Arrangements are made for improving the productivity of the pouring operations by bringing large quantities of hot metal to the work in bull ladles, by taking the molds to the melted metal, at or near the cupola, by trucks running on the floor, by cars on industrial tracks pushed by steam or electric locomotives and by conveyors on which the molds are weighted or clamped, sometimes jacketed, poured while in motion, cooled and removed at the proper time and flasks, bottom boards, weights, etc., returned to the molding stations while the sand and castings go elsewhere for suitable attention. There also are special forms of ladles, such as the multi-lip, which add to the productiveness of the labor.

In melting equipment, there is available for the cupola the tilting or rocking spout and the charging machine; for the reverberatory furnace in malleable work, the overhead traveler for lifting bungs and handling the fresh charge in dumping trays or skips; for the open hearth steel furnace, the charging machine and gas producer. To these two latter types of furnace, a number of attempts are being made to attach the mechanical stoker and to utilize also the direct burning of coal in powdered form. For non-ferrous metals, there is the tilting furnace.

In sand-handling, a number of devices are successfully used from the simple sand-cutting machine operating on the sand heap on the foundry floor to the complete apparatus which takes shaken-out sand, cools, cleans and tempers it, mixes it with the proper proportion of new sand and delivers it again to the mold maker.

In shaking out and handling castings, sprues, etc., mechanical appliances also have been developed from the simple grating on which molds are dumped to the complete conveyor which carries the shaken-out sand and castings to shaking gratings on which they are separated and from which they are discharged into some suitable arrangement for cooling, the sprues and runners having been disposed of at the proper time.

The cranes, travelers and industrial tracks, previously mentioned, also are available for this work, it being a matter for study in each case whether it is more economical to move the iron to the molds by hand or mechanical means, or vice versa.

When quantities are large and the product such that a few sizes of molds may be standardized, even though of considerable difference in size, there will be combined all of these devices, such as the molding machine, sand-handling system, mold conveyor and shaking-out conveyor, all of the operations being conducted uninterruptedly throughout the entire working day. Attempts have been made to operate such plants by means of two or three shifts throughout the whole 24 hours. The success of this development so far is doubtful. You will recognize that such 24-hour operation could not, in any way, increase the relative productivity of the labor.

Cleaning Castings

In cleaning, progress has been made from the hammer and chisel, steel brush and emery wheel to the power chipper, metal saw, sprue cutter, exhaust tumbler, sand blast tumbler and sand blast machine. Long tumbling mills have been attempted a number of times in which the castings to be cleaned were fed in at one end and discharged fully cleaned at the other.

These present attractive possibilities when material is fairly uniform in size and shape, and is not hollow, deeply cored, recessed or of considerable variation in size.

For these latter conditions, it has been found that while certain sizes in the charge may be satisfactorily cleaned in this way, the whole contents will not be as satisfactorily cleaned, so that on the whole, these devices have been a success only where the work is uniform in size and simple in nature. The exhaust tumbling mill and the sand blast machines, such as the revolving and traveling table machines and the sand blast barrel each are in satisfactory operation to increase the productiveness of labor in cleaning operations. Mechanical appliances embodying grinding wheels are available, increasing the effectiveness in removing roughness. They also are used to roughly-dimension such pieces as can be finished in this way.

Acid Cleaning

When large quantities of castings are made, which on account of being machined require careful cleaning to save time and tools, pickling plants, embodying mechanical handling, are designed in which the castings are handled on pans, acid poured upon them by ladles or from a hose connected with a reservoir to which the acid is again pumped after draining. The castings then are delivered to a washing floor where they are washed while still on the tray by streams of water under considerable pressure, after which they are dried and sorted. This means has given economical results for castings which are required to be very clean.

In the core department, various problems present themselves calling for the application of sub-division of labor and of mechanical devices; there are sand driers, mixers for properly amalgamating the necessary materials, ramming machines of various types, cutting-off and pointing machinery, handling devices for saving steps for the coremakers and ovens, more or less elaborate, for making the best use of time, labor and fuel.

A raw material yard also is a problem for engineering thought. There we have lifting and carrying machinery in the shape of locomotive and overhead cranes and industrial cars, together with scrap and pig breakers. There is also the sprue breaker, which simplifies considerably the handling of this awkward and bulky material.

Elevators to the charging floor usually come under the head of yard machinery, and here we have also the slag barrel and water barrel for preventing waste of material.

Attention is now being given to the saving of sand by rebonding processes in order to economize in raw material and in the disposal of waste, as in sand the binding material is but

a small proportion of the entire mass and injury to this binding element which prevents its further usefulness results in the loss of disproportionately large quantities of the refractory portion of the mass.

The Foundry Building

The building which is to house the proper arrangement of apparatus is also a subject for engineering thought. The first consideration, of course, is that the full possibilities of the arrangement of the apparatus and operations shall be developed. Care should be executed to prevent the manufacture of anything that might be an obstacle to the development of any particular function, that is, the building should be of such type of construction that changes in its form, openings, etc., may readily be made. The march of improvement is so rapid in this country that it is impossible to predict how often the manner of turning out products will be changed. The building, therefore, must be adaptable.

I personally prefer brick and steel construction to any other and have had no reason to alter this opinion after considerable experience in building this type of manufacturing plant.

Where much machinery is used, especially conveying machinery, it often develops that instead of using sub-grade construction, an advantage, both in first cost and operation, is gained by making the building of more than one story. This has led to the so-called two-story foundry, which is in successful use where the quantity of production is great and the use of machinery extensive.

Co-existent with the foregoing considerations are those of proper lighting, ventilation, heating, etc., that the human machine may operate in freedom from mental or bodily discomfort, thus securing the utmost which it is reasonable to expect from human endurance.

The construction itself calls for careful study that wear and tear from usage and the elements shall be properly attained without too great a first cost.

Among the elements to which the structure is most subject to attack is fire; principally from the inside on account of the nature of the occupation and somewhat from the outside, by reason of the proximity of other structures. There are available the sprinkler, the metal window sash, wire glass and the tile roof to minimize this source of loss. They are big dividend payers to the foundryman.

A considerable economy is to be attained in operation in the present state of the foundry business by the use of the well-recognized principles of sub-division and application of machinery and power. From a 50 per cent productivity in the case of labor not sub-divided and little or no machinery, to 75 per cent to be attained where these principles are most fully applied, represents a saving of 50 per cent.

A productivity of 75 per cent is, in my belief, about the limit that can be reached in the foundry art with such operations as are necessary at this time. There may be, of course, individual instances which will exceed this, but the figure refers to the average. It may be that we shall find in the permanent mold a method which will considerably increase the relative productivity of the labor. Time studies on repetition work to which the permanent mold would be applicable, show that there is many times as much labor consumed in making the present mold by present methods as is used in pouring and shaking-out, while the material handled in the making of molds is frequently ten-fold or more the weight of the castings produced. Also, there are several pieces of equipment to be handled to one casting or gate of castings. If the permanent mold could be developed these ratios would be cut down and less material as well as fewer parts would be handled. Of the 50 per cent increase in productivity of the man, at present available, however, you can all secure a part. Some sub-division of labor and some mechanical apparatus is applicable to part or a whole of the operations in the jobbing shop and in the shop which handles a considerable range of standard work.

A mechanical engineer and manufacturer of world-wide reputation has said that "the achievement of a result regardless of cost, is not engineering." Having this in mind, it is essential to carefully study all conditions.

In arriving at a practical conclusion as to the installation of machinery and the sub-division of labor, the cost of installation and operation and the possible increase of product must be considered as well as the increase of productiveness of labor.

We have been called upon to examine cases where unintelligent application of mechanical devices materially diminished the productiveness of the labor in addition to entailing heavy expense in installation and operation.

On the other hand, the highest productivity and hence, greatest economy in production have been obtained where the apparatus and sub-division of labor have been most intelligently employed.

Blow Holes and Sulphur

By R A Pitman

THESE few remarks were inspired by reading W. F. Prince's article in the February issue of THE FOUNDRY, entitled "Opportunities for the Foundry Engineer." Mr. Prince speaks of passing air through a ladle of iron from a pipe in the bottom and he found that the air removed a portion of the sulphur from the body of the metal. The sulphur was carried to the surface, where it appeared as a high percentage of the kish skimmed from the ladle and the operation further checked, by an analysis of the iron in the ladle, showed a reduction in the percentage of this element over that contained in the metal before it was so treated.

Here again, as in many other lines, the permanent metal mold offers an opportunity to study the causes and effects in the iron casting industry as no other process possibly can do. While working with these molds, conditions many times have arisen whereby the resulting castings, when broken open, were found to contain a large number of blow-holes at or near the top, while the other portions of the castings were free from such defects. Analyses of samples taken from the portions showing the holes invariably indicated these parts to be much higher in sulphur than other portions of the castings and, therefore, the blow-holes were always attributed to this element entirely. This was proven to be unfair to our friend the enemy (sulphur) as the trouble is not entirely due to the presence of this element. It alone in the usual percentages would be harmless in metal molds.

Entrained Air

We have all noticed that when we fill an ordinary drinking glass with water from a faucet, more or less air is carried beneath the surface of the water by the action of the stream falling into it and the higher the velocity of the falling stream the greater the amount of air which is carried underneath the surface. The same thing occurs when any stream of molten metal is poured into another body of metal, which

usually is the case while pouring large castings. The metal in the pouring basin, which receives the falling stream, is continually being charged with entrapped air and the velocity of the metal passing through the gate often is too great to permit the entrapped air to find its way back to the surface of the pouring basin and it is carried onward into the mold. Then in rising through the iron it gathers unto itself all the sulphur with which it comes in contact and carries it along to the surface where, in some cases, it escapes through the surface of the iron and overlying sand of the cope. In other instances, as in metal molds, it is prevented from escaping by a skin formed over the surface of the iron by contact with the mold and this results in the section of the casting being full of blow-holes, showing high sulphur content.

Who has not noticed, when pouring large castings, that immediately upon stopping the stream of metal at the end of the pouring operation, the metal bubbles in the pouring basin? This is caused by the entrapped air which has been prevented from escaping sooner by the action of the falling stream, but as yet has not been caught and carried onward into the interior of the mold. As soon as the pouring operation is finished and the metal in the gate stops flowing, this air escapes, but that part of the entrapped air which has been carried along to the interior of the mold may not have time or opportunity to escape through the cope and if it does not, the resulting blow-holes are sure to be attributed to sulphur on account of the fact that the air has gathered up this element in its passage through the iron.

Cause of High Sulphur

It is not at all likely that one small portion of a large casting will be appreciably higher in sulphur content than other portions of the same casting, unless something has occurred to gather it up and deliver it to one spot. This same entrapped air, in all probability, is responsible for the dross spots often found in castings made from the most carefully cleaned and skimmed metal in the brass foundry, particularly manganese bronze.

Evidently in this case, the remedy lies in preventing the air from entering the mold, either by such method of pouring as will preclude the possibility of entrapping the air which, of course, is rather difficult, or in compelling the entrapped air to remain at some point outside of the casting. This was the method pursued in obviating this difficulty in casting in permanent molds and it proved to be entirely efficient. The castings thus made were free from blow-holes, while the part arranged to hold the entrapped air was rotten with sulphur.

It should be noted that the entrapped air alone would have caused the holes or the spongy spots, but the sulphur alone, if it had been allowed to remain uniformly distributed throughout the iron, would not have had any bad effect whatever. However, since it was found in larger amounts in the faulty locations, it brings upon itself all the blame for these defects, which it alone is not at all likely to cause.

Holding an Electrical Manufacturer's Business

By A B Reynders

IN THE old days, in line with the general development of apparatus, railway motors were made of cast iron. Today, the frames are made of steel, while the revolving parts contain laminated steel, malleable iron and, of course, the necessary amount of copper, insulation material, etc. Railway motors usually are made in large quantities and, therefore, the steel foundries consider an order for these castings quite desirable. Unfortunately for both the foundries and for the electrical manufacturer, the castings are paid for on the basis of weight. The modern tendency toward weight reduction in railway apparatus follows very closely that for all lines of electrical apparatus except that it is much more pronounced. In other words, all things being equal, a railway company will choose the lightest motor that will perform the service.

The reason for this is obvious, and, is the same as the requirements in automobile practice with which we are all familiar. The company which produces the lightest car, if all other conditions of power, speed, comfort, etc., are equal, will usually make the sale. No railway company desires to haul around several hundred pounds extra weight in the frames and armatures of motors if it can secure a lighter motor that will haul just as much total weight, or, in other words, will haul more passengers. Great insistence has been placed within the last year or two upon light weight motors. Every effort is being made by the manufacturer to reduce the weight of motor frames to the very minimum which will allow for a good casting.

In steel, this minimum invariably is greater than that required for either electrical or mechanical reasons. Unfortunately, the demand for light castings has not been met with very great success on the part of the foundries.

It may be unjust to accuse them of the short-sighted policy of negligence in attempting to reduce the thickness of section in making these castings. It may be stated, however, that unless more success is obtained in reducing these thicknesses, the foundries will force the electrical manufacturer to some other form of steel. At the present time, the Westinghouse company has developed and has shown to the public a pressed steel type of railway motor, the greatest advantage of which is light weight and uniform material. Of course, the production of such a motor involves a tremendous expense in the development of tools, but if sales in quantity can be made on the basis of the light weight, the cost of these tools can be readily absorbed. In other words, this means that the steel foundries will obtain less and less business. It, therefore, behooves these foundries to carefully investigate methods of casting which will allow them to reduce thicknesses to the minimum requirements of electrical and mechanical design.

Uniformity in Weight Desired

Moreover, a greater uniformity in weight must be maintained. A customer always looks with suspicion upon a manufacturer who furnishes him a sample of light weight and then, upon obtaining his regular production, finds that the weight is increased from 8 to 12 per cent. A correction of this trouble lies with the foundries themselves, in that the inspection of shipment must be more rigid, and castings overweight should be rejected. Of course, this appears, on the surface, to be a losing proposition; but, as stated above, unless it is done, sooner or later, the foundries will obtain no business from the electrical concerns.

In the manufacture of large direct current electrical machinery, steel is rapidly replacing iron, especially when speeds, and, consequently, mechanical strains are high. In the old days, when slow speed engines were used for prime movement, electrical generators were large in dimensions and the frames were

*Portions of a paper read at a meeting of the Pittsburgh Foundrymen's Association, Dec. 7, 1914. The author is director of production, Westinghouse Electric & Mfg. Co.

usually cast iron. With the advent of modern high speed alternating current turbines, cast iron became unsuitable except merely as a retaining shell to hold high grade material.

In the case of the revolving part, the best obtainable material from both magnetic and mechanical requirements is none too good. Steel, therefore, has been used exclusively, but either in the form of a forging or else in the form of a specially heat treated casting. This revolving part is usually known as a disc and consists mainly of a large cylinder sometimes with the shaft ends cast thereon and other times not. For the standpoint of the foundry which has not had experience with the manufacture of this solid steel cylinder or disc, this business appears to be highly desirable and easy to produce. But although a simple casting, the rigid requirements are such that only after a large experience can such castings be produced profitably. This is simply another phase of the fallacious idea of obtaining castings by weight.

Let us now consider the field of the smaller castings. Whenever it is desired to secure small castings, particularly of steel, the question of sections is of vital importance. Owing to its higher magnetic qualities, steel would be used in many more cases if the section of the metal could be reduced and a uniform, clean casting be produced.

Malleable Castings Popular

As an example, let us take steel castings commonly used for the lighting generators on automobiles. If a section of ⅛-inch or even ¼-inch, could be obtained, it is probable that cast steel would be retained. As it is, the tendency in the design is toward the use of a forged frame, the reason being that the machine will be considerably lighter and the performance much more uniform. We all know that the question of weight is vital in an automobile and automobile manufacturers are now specifying to electrical manufacturers that their lighting and starting motors come within certain weights. With the use of cast iron, it is impossible to meet these specifications. For starting motors in which the mechanical requirements predominate, it is found that malleable iron will give sufficient magnetic performance and, owing to the fact that usually it is cheaper and the weight less than steel, due to smaller sections, it is being used at present.

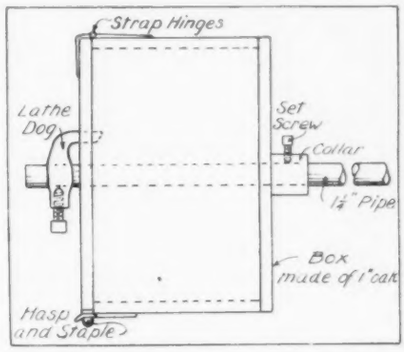
In the case of lighting generators, where the magnetic material must be of the highest quality cast steel is being used or else forged steel frames. Here again, due to inability to cast thin sections, the tendency is away from steel castings. Even malleable iron, which is cheaper than steel, cannot compete with the forging either in price or in quality.

It is needless to say that in all these small steel castings the freedom from hard spots and sandy surface is essential, otherwise the amount of material allowed for finish is greatly increased. Therefore, the weight will be increased and immediate investigation will be made toward the use of other materials tending to a reduction in price and weight.

In the foregoing but little has been said regarding deliveries. Often the material used is determined upon ability to obtain it quickly. In such cases, malleable iron usually suffers—cast iron gets the preference. Competition in the delivery of electrical apparatus is so keen that it is essential whenever malleable iron is used to either carry a stock or else take the chance of losing the job. On steel, fairly quick deliveries can be obtained by pressure.

To draw a few conclusions, it may be said that, as a general proposition, the use of castings in the production of electrical apparatus is diminishing and, in order that this state of affairs may not be further augmented, it behooves the foundries to make improvements in their product along the following lines:

First, increase the permeability. By this is meant, increasing the quality of the material so that it will become a better magnet. At the present time the only known method of accomplishing this is by annealing. In other words, castings must be soft. Not only does this help the permeability, but it also helps decidedly in machining operations. *Second*, decrease the sections and weights. *Third*, supply uniform material, both electrical and mechanical. *Fourth*, make quick deliveries.



TUMBLER FOR LIGHT CASTINGS

A four-page bulletin has been issued by the Stow Mfg. Co., Binghamton, N. Y., which shows various combinations of a flexible shaft and electric motor for drilling, grinding, buffing, die-sinking and screw driver work. The bulletin is illustrated showing the suspended type of tool, the tool supported from a floor stand and the motor-driven two-spindle drill manufactured by this company.

A Home-Made Tumbler for Light Castings

By N. Liscomb

The tumbler for light castings, shown in the accompanying illustration, can readily be made in any foundry or machine shop. It consists of a box, a bushing with set screws, a dog and a section of pipe. The box should be provided with a hinged cover which can be located, as indicated, and it is needless to say that the box should be made of sufficient strength to withstand the tumbling of the castings. The one shown is about 18 inches square and 12 inches deep. A section of 1¼ or 1½-inch pipe, about 4 feet long, is inserted through the center of the bottom and the cover of the box and extended several inches beyond the cover. On this cover pipe extension a dog is attached to the pipe with the shoulder inserted in the hole in the cover. A bushing or collar is passed over the pipe, being fitted with set screws and is pushed up against the bottom of the box. The pipe then is inserted in a pipe threading machine or a lathe and is revolved. To discharge the contents, the dog is removed and the box is pulled partly off the pipe.

Comments on Fuel Ratio for Car Wheel Iron

By A. S. Dowler.

In the February issue of THE FOUNDRY, page 51, is published an article entitled "Fuel Ratio on Car Wheel Iron." Having had a wide experience in car wheel manufacture, I would like to correct some of the statements made in this article. No successful car wheel manufacturers in the United States obtain as low a melting ratio as 10:1. The writer has visited foundries where it was claimed that 10:1 was obtained, but after careful investigation he found in every case that the ratio was more nearly 7 or 8 to 1 instead of 10:1. Recently I was in a car wheel plant where a 10:1 fuel ratio, minus cupola bed which consisted of 3,600 pounds, was tried. Heats ranging from 50 to 60 tons were taken off, but the results were disastrous. The wheels were not standing up to any of the Master Car Builders' Association tests nor were they taping right. The hubs contained large shrink-holes for which the molder, of course, was blamed for permitting the slag to get into the wheels while they were being poured. After the fuel ratio had been changed all of the defects were eliminated and this proved that the molder was not at fault, but an insufficient amount of fuel was used.

It has been my experience that shrink-

age in the wheel does not occur immediately, but requires from four to five minutes to shrink completely on account of the large amount of metal poured into the mold. I have made numerous experiments to ascertain how long it will take after the wheel is poured for the chill and wheel to separate and I found that it was eight minutes on a 750-pound wheel before any separation was noticeable. This proves to me that the shrinkage does not occur instantly. This experiment was made by ramming a wheel with the finished cores in place, but the sand was cut out between two bars in the cope on opposite sides. The cope was closed onto the drag and the wheel then was poured in the customary manner. There are no less than 25 different causes for chill cracks and as many different remedies. A chill crack occurs in a wheel during solidification, which takes place gradually and it would be impossible to remove the chiller from the wheel and to hurry the casting to the pit without injury, which in no way would eliminate chill cracks. No foundryman has ever seen a wheel chill-crack, but these defects can be remedied by good foundry practice only.

Making car wheels with coke pig iron and steel scrap is not necessarily considered an accomplishment by wheel makers today. While the writer is not a chemist he has used steel scrap in car wheel mixtures for the past ten years with excellent results.

Cupola Bed and Blast Pressures

By Richard Moldenke

A QUESTION has been asked with reference to the statement that only the top 4 inches of the fuel bed of the cupola is effective, and why the first charge of metal should be no heavier than the rest. The reply would be that of the entire bed charge of coke, that portion below the tuyeres is simply so much filling to enable the storing of molten metal in the cupola. In European practice, where the forehearth is used, the tuyeres are on the bottom and the metal runs out through the breast as fast as it melts, suitable provisions being made to keep in the wind. This mode of operation saves just that much coke daily. The rest of the coke bed, above the tuyeres, serves to give the blast an opportunity to burn the fuel to produce the necessary melting heat. While the reactions are almost instantaneous, nevertheless it takes a given time to complete the burning in question, and inch-by-inch upward, above the tuyeres, the temperatures increase as the oxygen is consumed. The finished reaction is to be found in the last 4 inches of the bed, where there is a maximum of carbonic acid, a minimum of free oxygen and a maximum of temperature. Here is the place to melt the iron, and neither below nor above. To find this place, practice has shown that after charging the cupola in the usual way and putting on the blast, the time from *blast-on* to *first iron* should be between eight and ten minutes, first iron meaning when the molten iron begins to run over the spout. In well-designed cupola installations, this should mean a height of bed above the tuyeres of 22 to 24 inches. Where the blast is excessive it will have to be higher, but where insufficient air is given it may be a trifle lower; this practice, however, is not economical.

Since this most effective part of the fuel bed—this upper 4 inches—should do all the melting, it stands to reason that its position should not be changed any more than can be helped. Hence only sufficient iron should be charged on the bed to use up 4 inches of coke, and when this metal has been melted another 4 inches of coke should be on hand to bring the bed up to the original height again. Hence the necessity of having the first, second, and every other charge of metal exactly the same in weight, and to have every intermediate charge of coke the same, or just enough to keep up the bed to the proper point; toward the end of the melt, when the cupola is very hot, some coke can be saved.

The idea of big first charges evidently can be attributed to the idea that with a big bed charge of coke, a big bed charge of metal is necessary. A study of the situation, as indicated above, reveals what a fallacy this is. Indeed, one would be laughed at in Europe to suggest such a procedure; hence the desirability of weighing the volume of coke filling up 4 inches of the cupola height, and proportioning the metal charges therewith. Ordinarily this is ten times the weight, but with high ash coke it is less. Once operating this way the daily observation of the cupola lining should show a scoring of only 9 inches to the foot, whereas with big first charges and a consequent fluctuation of zone of melting, it may extend over 3 feet.

The question has been asked, "What is the correct blast pressure for a 48-inch and a 56-inch cupola?" The reply would be that there is no such thing as a correct blast pressure. With the same speed of the blower and melting iron steadily and properly, the first part of the heat, with a clean cupola, will show low pressures. As the cupola slags-up and the wind cannot pass through as readily, the pressure (positive blower) rises. Hence, what good is the pressure indication? On the other hand, the *volume* indications are essential. The requirements of good cupola practice are a steady, strong blast of air, of absolutely constant volume, so that the same weight of fuel is burned for every minute of operation. This volume of air should be adapted to the diameter of the cupola, so that a given melting rate of metal eventuates. It should not be changed through the melt, and if iron comes too fast, better shut-down for a few minutes, but do not slow up the blast, as it changes the position of the zone of melting and makes trouble when full blast is put on again.

Now for the two sizes of cupolas asked for—the 48 and 56 inch—the best practice has shown that the melting rate should be eight and ten and one-half tons of molten metal per hour, respectively. Since it takes roughly 30,000 cubic feet of air to melt one ton of iron, it is easy to calculate the amount of air that should be blown into the cupola in each case, the calculation being brought down to actual revolutions of the blower. Hence, what does the pressure have to do with the situation?

It may be stated finally that the above deductions are the result of the government experiments at the bureau of mines, and were originally laid out by the writer. These tests are comparatively recent, as the history of iron melting goes, and hence are not as well-known as they should be. Considering, however, the wonderful improvement that comes to foundries formerly in constant difficulty with their cupola work, where these principles have been applied, it may not be incorrect to claim that these tests are the most important that have ever been made in the entire history of the foundry industry. The report may still be had from the bureau of mines, Washington, D. C.

Wightman D. Roberts, Huntington, W. Va., has written and published an interesting booklet entitled "The Man with a Job". It aims to bring out clearly some of the arguments against socialism and government ownership. It is written in the first person and was prepared as the result of a suggestion by a manufacturer to provide something that would fortify his workers against socialistic literature and the professional agitator.

How Institute Students Cast a Gasoline Engine

Descriptive Details of the Work, Including the Molding, Core-Making and Casting of Air-Cooled Cylinders

By F F Hillix*

IN MAKING the castings for a small, air-cooled gasoline engine, a number of instructive problems in foundry practice are encountered. At the same time the finished machine is bound to be an object of considerable interest to a youthful mind with mechanical inclinations. For these reasons the 12 weeks' course in foundry work at the Stout Institute, Menominee, Wis., concludes with making the molds for a two-cycle 2½ x 3-inch, air-cooled, single cylinder engine which would be suitable for a small boat, motor cycle or light cycle car. The foundry course covers eight hours a week, or 96 hours altogether. The two-cycle engine is a simple one for the machine shop classes to finish and the air-cooled engine is more easily cast in the foundry than the water-jacketed type.

The pattern is shown in Fig. 3. The right hand end including the print for the inside core and the bottom flange is cast in green sand. The left end with its large, square core print forms the top end of the cylinder. The air cooling flanges are cast in a core using a square print. It is the intention to use the same pattern and by the use of an extra core, make water-cooled engines. This will be a convenience to the foundry instructor, because all the port cores and the core for the bore will then be standard.

Fig. 4 shows the core boxes and the two halves of the core for the bore. The small, rectangular projections in the boxes at *A*, *B* and *C* are prints for the port cores. The by-pass core fits into the two prints at *A*; the exhaust port fits into *B*, and the inlet port into *C*. Before pasting the halves together, a vent is scratched in each half of the

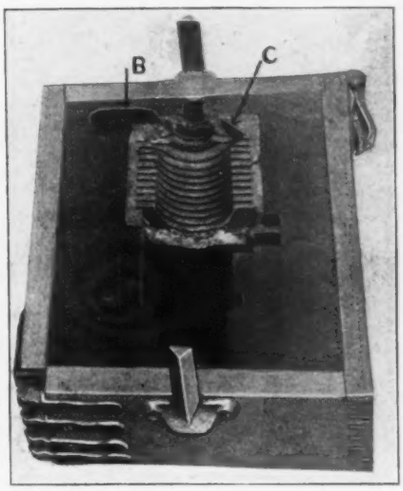


FIG. 1—THE MOLD READY TO RECEIVE BARREL AND BY-PASS CORES

core leading from end to end. A small hole is bored from each port core print into this vent. In Fig. 5 are shown the component parts of the core boxes to produce the exhaust core *A*, the inlet core *B*, the by-pass core *C*, and the cores for the air-cooled flanges, *D*, *E* and *F*. Fig. 6 shows the exhaust port core and box at *A*, the by-pass core and box assembled at *B*, and the inlet core and box at *C*.

The core box for the air cooling flanges is shown in Fig. 7, and consists of the following principal parts: The slotted casting, *A*, the frame, *B*, and slides, *C*. The casting, *A*, is the shape that is desired for the outside of the upper part of the cylinder exclusive of the air-cooled flanges. This must be finished carefully so that both sides are symmetrical, because both cores are to be made from it. The slots for the semi-circular metal pieces, *C*, are then carefully spaced and cut through. These slots must be absolutely square with the center line of the cylinder or the flanges will not meet at the parting line of the pattern. The flanges are 1/16-inch thick and ¾-inch wide. The error necessary to make a very rough casting is exceedingly small. The frame, *B*, makes the square part of the core. Here, again, the work must be exact, because all errors are doubled when the two halves of the core are assembled. Allowance must be made for the rap of the pattern and the box, because the core must just fit in the mold.

The box is turned over from the way it is shown in Fig. 7, and a small clamp is put on to hold the frame together. The slides are pushed down so that they are flush with the surface of the bottom. The box is then filled with core sand, rammed in the usual way

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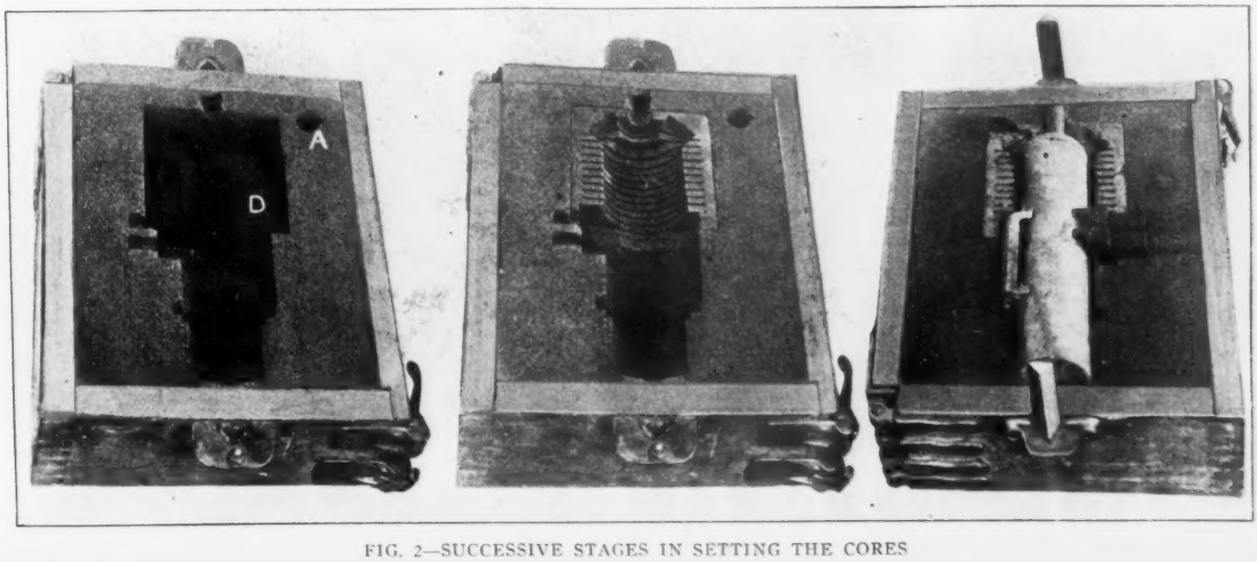


FIG. 2—SUCCESSIVE STAGES IN SETTING THE CORES

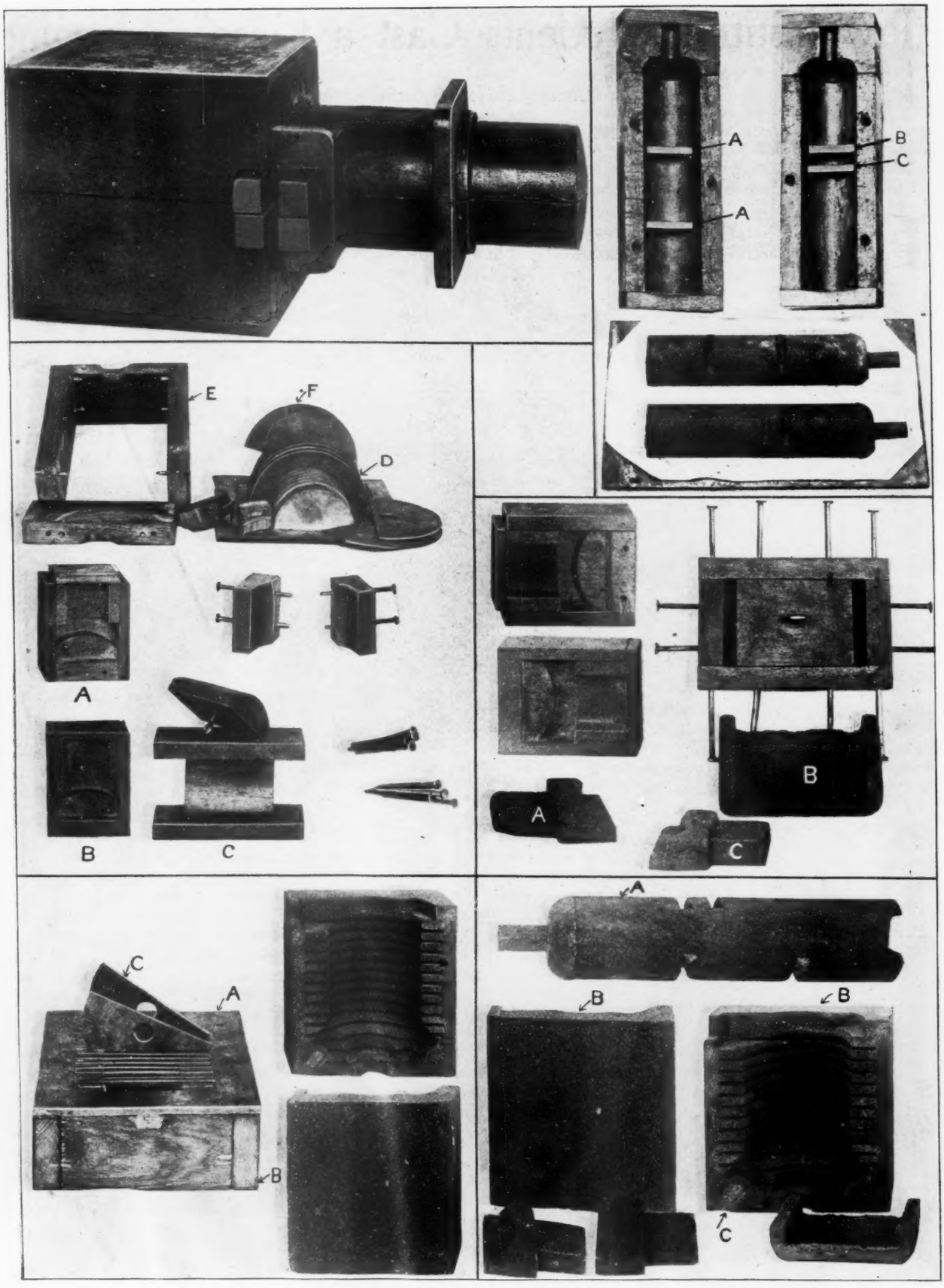


FIG. 3—PATTERN FOR GASOLINE ENGINE
FIG. 5—CORE BOXES FOR VARIOUS SMALL PARTS OF ENGINE
FIG. 7—MAKING CORE FOR AIR COOLING FLANGES

FIG. 4—BARREL CORES AND CORE BOX
FIG. 6—EXHAUST PORT, BY-PASS AND INLET CORES AND BOXES
FIG. 8—FINISHED CORES READY TO GO IN THE MOLD

and the core struck off flush with the top of the box. A plate is put on, and the box is next turned over and rapped slightly. The slides are drawn as shown in Fig. 7, the casting, *A*, acting as a stripping plate. This makes the flanges. The casting, *A*, is next lifted off. The frame, *B*, is made of four pieces and is carefully removed, a piece at a time. The core now is ready for the oven.

Fig. 8 shows the complete set of cores, the core for the bore, *A*, having been pasted together. The pouring gate is filed in the corner of the core, *B*, as shown at *C*.

Figs. 1 and 2 show the mold made in a snap flask with the sprue pin hole at *A*, the runner at *B* and the core in place at *C*. The other flange core at *D* has not been set. At the right, in Fig. 2, the mold is shown with the cores in place and ready to close. It is important that all the loose sand is blown out of the gate and mold before closing. It is well to measure the cores to ascertain if they have been pushed down properly, to avoid cutting through the casting on the cope side.

Fig. 9 shows the casting at *A* as it comes from the sand. The risers are made by pushing a large ¼-inch vent wire through the cope before closing the mold. We found that if a large riser was used, it drew from the casting and caused a hole at the place where it joined the latter. The casting averages only ⅛ inch in thickness, so a riser is hardly necessary.

The gate pin is 1¼ inches in diameter and the iron must be put in as fast as it will run down this hole.

FIG. 9—ROUGH ENGINE AND MOTOR CASTINGS

This is the reason for the large basin at the top. At *B*, Fig. 9, is shown one of the castings for a small sewing machine motor. This casting is about 7 inches in diameter and ⅛ inch in thickness. Fig. 10 shows a group of engine cylinder castings and also one that has been cut into sections. For work of this character, the cores must vent freely and be true to shape. For the cores we use a sharp sand, that is reasonably coarse, and for a binder resin, 1 to 24 and linseed oil, 1 to 48. These cores do not require any blacking and are easy to remove from the casting. Glutrin works well if the mold does not stand over night with the cores in it.

Obtaining the proper iron is no small factor in successfully making cylinders, so I will describe briefly the method used in handling the cupola, which follows closely the methods advocated by Dr. Richard Moldenke. The bed charge of coke must be of the proper height to bring down iron in eight minutes after putting on the blast. If iron comes down before the blast has been on eight minutes, the bed charge is too low. If more than eight minutes, the bed was too high. The cure to be used in either case is obvious.

The bed must be burned through to a nice red heat before charging the first iron. In charging, mix all the iron and coke in proper ratio before shoveling into the cupola. This seems to be the really new part of the method. Break all the pig iron, and for a small cupola lined to 18 inches break each pig into three or four pieces. This is important if you want hot iron. Break up the scrap into small pieces so that two or three pieces cannot wedge across the cupola and bridge.

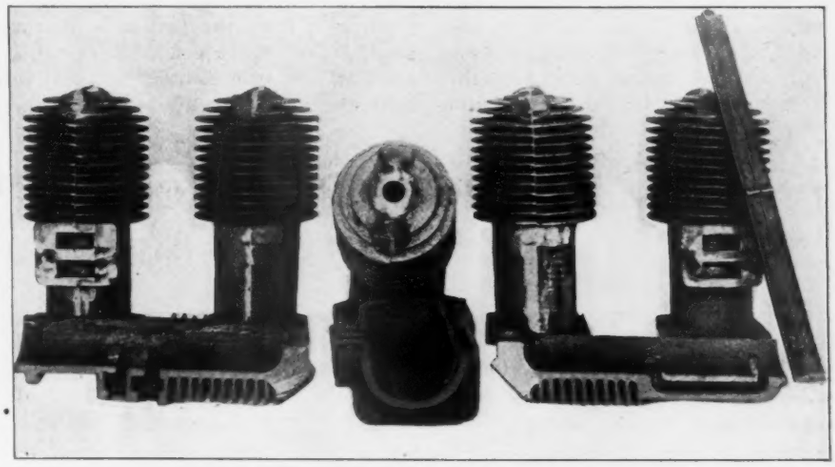


FIG. 10—FINISHED ENGINE CYLINDERS

To cast the cylinders shown we used 75 per cent A. A. Scotch pig and 25 per cent machinery scrap. They are all that could be desired in softness and clean iron. The charging directions are as follows: Spread 500 pounds of machinery scrap in a windrow on the charging floor and spread 62 pounds of coke uniformly over the top of the iron. Four hundred pounds of Scotch pig and 100 pounds of machinery scrap are spread in a windrow beside the first charge and 62 pounds of coke is spread over the top as before. Additional iron and coke is brought up and mixed as needed.

When all was in readiness with the bed burned through, the charging was begun. As soon as the cupola was full to the charging door the blast was put on. The charging was continued as needed to keep the cupola full. When charging the pig iron, care was taken to have the pigs fall in the center of the cupola to avoid oxidation of the iron.

The 500 pounds of scrap iron were charged first and were held until by timing we were sure that the 500 pounds were melted. This was tapped out and the iron and slag allowed to run until the cupola was drained-out clean.

This iron, while it flowed white hot, was chilled somewhat by the ladles so that it was not adapted for the thin work. It was used for castings more than ¼ inch in thick-

ness. As soon as the ladle was empty, it was scraped out and made ready to receive the pig iron. This was tapped out when the proper time had elapsed to melt about 450 pounds. This was done to avoid getting any scrap from the following charges. At the first sign of slag, the bod was put in. This iron was used for engines, motors and all small, thin castings that were likely to chill if made of scrap iron. As the ladles were hot, this iron was very fluid. To test the iron we use a wedge ¼ inch thick, 1 inch wide and 12 inches long, tapered out to a shaving at the thin end. The iron will often run to the end of the wedge and half way through the cope to a ⅛-inch vent hole.

Do not let any slag run out on top of the iron when tapping the pig iron. Also skim the iron carefully when pouring it from the bull ladle to the small ladle. We use a wide skimmer so that the iron is really taken an inch or more below the surface of the metal in the bull ladle. If the iron is treated in this way, no trouble from dirty iron should occur. Iron melted as outlined will show clean and sound after machining the cope side of a casting.

In pouring the cylinder, dump the iron as fast as it will run in and try to keep the pouring basin full. It is important to avoid slopping iron into the gate in trying to find the hole, since it causes shot iron and defective castings.

Insufficient Air for the Cupola

By W J Keep and George C Hicks

Question:—Our cupola is lined to 48 inches, the sill of the charging door being 16 feet, 9 inches above the top of the tuyeres, the latter being continuous, having an area of 756 square inches. The entrance to the tuyeres is 636 square inches and the opening through the cupola shell is 480 square inches. The area of the cross-section of the blast belt is 228 square inches and the area of the blast pipe on entering the blast belt is 201 square inches. The blast is delivered by a blower speeded to give 4,500 cubic feet of air per minute, but only 3,800 cubic feet enter it first and during the first 15 minutes this decreases to 3,500 cubic feet per minute, which melts seven tons per hour. The metal is subject to excessive oxidation, due to the high pressure, which is about 16 ounces. How can I melt nine tons per hour and increase the volume of blast to 4,500 cubic feet of air per minute? What is retarding the passage of air? I do not want to use more than seven or eight ounces pressure. The coke bed is 1,300 pounds and reaches about 28 inches above the tuyeres. The other charges consist of 250 pounds of coke and 2,500 pounds of iron. While the iron is hot, it does not melt sufficiently fast.

Answer:—Since this inquiry involves so many interesting points regarding volume of air and blast pressure in cupola practice, I requested George C. Hicks, vice president and engineer of the P. H. & F. M. Roots Co., Connersville, Ind., to make a reply. Mr. Hicks sums up the situation as follows:

The inquiry indicates some misapprehension in regard to the relation between pressure and volume when the air is used for melting iron in the cupola. Of course, it is unnecessary to state that a certain definite quantity of coke and air are required to melt a certain definite quantity of iron, with conditions normal. There may be an excess of either coke or air, which would have a tendency to decrease the melting ratio below that secured with normal conditions. For the average condition of cupola service, 500 cubic feet of air per minute is required for each ton of iron melted per hour. This represents a fair average, but decreases in cupolas of large size and increases in small cupolas. However, a 54-inch cupola, inside of the lining, would about represent a requirement of 500 cubic feet of air for melting one ton and for sizes above this the amount of air gradually decreases. Exceptions are due to conditions under which the cupola is operated and mainly consist of the character of the charge.

Iron Broken Small

If the iron is broken into comparatively small pieces, the charge becomes more dense, the pressure somewhat higher, the melting faster and the use of air more efficient, as there is more intimate contact between products of combustion of the air with the coke and the iron to be melted than where the iron is charged in very large pieces or where the scrap is of such character that it represents large volume without much weight. Having enclosed air spaces, the efficiency of the air is lower and the products of combustion escape at a higher temperature, thereby decreasing the efficiency of the cupola as a whole. From this it follows that the free space of air passage should bear a certain definite proportion to the cross-sectional area of the cupola and to keep this constant for different sizes, the charge should be broken up more in small cupolas than in large furnaces. Where large pig or scrap is charged into a small cupola there will be low efficiency, due to the fact that products of combustion are not brought into intimate contact with all parts of the iron to be melted.

The question of bed charge and charges after the bed need not be considered in this connection, except to state that the bed charge is usually about 2:1 and the succeeding charges 10:1. In cases of long heats a still further decrease in the amount of coke may be made, thereby securing a better ratio of iron to coke. The principal point to be observed in a bed charge is the amount of coke which should be sufficient so that when the iron is brought to its melting condition, it should be in the melting zone, which generally is from 10 to 14 inches above the tuyeres, and each succeeding charge, as it comes down, should be melted in this zone. The narrower the zone the greater uniformity there is in the melting conditions, or to state the contrary, if the melting zone is wide, it indicates that the charges of iron are not entering the melting zone uniformly and are traveling too far before being converted into fluid iron. It will be noted from the statements made in regard to the density of the charge that the loss of pressure is due to this density and the total height above the tuyeres. The loss from the blower to the tuyeres is a constant amount for a given quantity of air and seldom exceeds 1 or 1½ ounces. It is not necessary that the tuyeres should be continuous, the only important factor being that the air should be thoroughly distributed into the charge at the tuyere line. The greater the diameter of the cupola the more essential it is that the air should enter with sufficient velocity to carry it to the center at least. There may be, however, a wide variation in tuyere area. The only point necessary to guard against is that it shall not be less than the minimum for good practice. This is well taken care of by the cupola manufacturers and needs no discussion.

For the cupola referred to in the inquiry, which is lined to 48 inches, the tuyere area need not exceed 350 square inches. Therefore, we have established

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

RECOMMENDED PRACTICE FOR THE ANNEALING OF CARBON-STEEL CASTINGS*

1. The castings should preferably be sufficiently cleaned of adhering sand before annealing to insure thorough and uniform heating.

2. The castings should be heated slowly and uniformly to temperatures varying with the carbon content of the steel, approximately as follows:

Carbon, Per Cent.	Temperature, Degrees Cent.
Up to 0.16	925
0.16 to 0.34	875
0.35 to 0.54	850
0.55 to 0.79	830

Nothing in these recommendations shall operate against the temperatures aimed at, being 50 and, in special cases, 100 degrees Cent. higher than those given in the table, when necessary to attain the desired result.

3. The castings should be kept at the maximum temperature a sufficient length of time to insure the refining of the grain. In general, the heavier the sections of the casting, the longer must be the time of exposure to the maximum temperature.

4. (*a*) The castings should be cooled slowly and uniformly in the furnace, when it is desired that the steel shall possess the maximum softness.

(*b*) The castings may be cooled at an accelerated rate, when it is desired that the steel possess rather higher tensile strength and elastic limit than can be procured by very slow cooling. This cooling must be so conducted as to leave the steel reasonably free from cooling stresses.

The manner of carrying out this accelerated cooling should be such as will attain the desired result. For instance, the castings may be withdrawn from the furnace and buried in a bed of material that is a poor conductor of heat; or the annealing furnace may be so thrown open that it will cool more rapidly than if left closed. Should the castings be of such uneven section that they cool at unequal rates at various points when the furnace is opened, especially if the carbon of the steel is high, the furnace should be closed after the castings have become black, and their further cooling so retarded that the stresses set up by the unequal rates of cooling are relieved.

*Adopted by the American Society for Testing Materials.

RECOMMENDED PRACTICE FOR HEAT-TREATING CASE-HARDENED CARBON-STEEL OBJECTS*

It is recommended that the following treatments be applied to case-hardened carbon-steel objects according to requirements:

1. When hardness of case only is desired and lack of toughness or even brittleness unimportant, the carburized objects may be quenched from the carburizing temperature, as for instance, by emptying the contents of the boxes in cold water or in oil. Both the core and the case are then coarsely crystallin.

2. In order to reduce the hardening stresses and to decrease the danger of distortion and cracking in the quenching bath, the objects may be removed from the box and allowed to cool before quenching to a temperature slightly exceeding the critical range of the case, namely, 800 to 825 degrees Cent. Both the core and case remain coarsely crystallin.

3. To refine the case and increase its toughness, the carburized objects should be allowed to cool slowly in the carburizing box within the furnace or outside to 650 degrees Cent. or below, and should then be reheated to a temperature slightly exceeding the lower critical point of the case (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees Cent. will be suitable), and quenched in water, or, for greater toughness but less hardness, in oil. The objects should be removed from the quenching bath before their temperature has fallen below 100 degrees Cent. This treatment is more especially to be remommended when the carburizing temperature has not exceeded 900 degrees Cent. It refines the case but not the core.

4. To refine both the core and the case and to increase their toughness, the objects should be allowed to cool slowly from the carburizing temperature to 650 degrees Cent. or below and should then be (*a*) reheated to a temperature exceeding the critical point of the core, which will generally be from 900 to 950 degrees Cent., followed by quenching in water or in oil; and (*b*) before they have cooled below 100 degrees Cent., they should be reheated to a temperature slightly exceeding the lower critical point of the case (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees Cent. will be suitable), and again quenched in water or oil.

*Adopted by the American Society for Testing Materials.

the fact that the pressure up to the point of the tuyeres is practically a constant and, therefore, it follows that the additional pressure required to force the air through the charge is dependent entirely upon the total depth of the charge. As this air becomes heated after the cupola is in full blast, the pressure increases, due to the fact that the gases, by expanding, have increased in volume, while the openings through the charge have remained practically constant. It follows, therefore, that it is impossible, with a certain depth of charge, to state that the pressure at the cupola and the amount of air shall be any certain fixed figure.

The cupola referred to has an exceptionally high charging door and it is evident that the pressure of 16 ounces at the blower is not sufficient to force through the cupola the amount of air required for a nine-ton per hour melt without exceeding this pressure. As the relief valves undoubtedly were set at 16 ounces, when the pressure rose above that point and the excess demanded by the cupola for the necessary melting was wasted through this escape valve, the rate of melting of the cupola diminished in proportion. The solution, therefore, is obvious. Either the safety valve on the blower must be increased in weight to give the necessary pressure to force 4,500 cubic feet of air through the cupola or the depth of the charge must be reduced until 4,500 cubic feet of air will pass through the furnace at a pressure from 12 to 14 ounces, which would be about normal for a cupola of this size, and should correspond with normal charge to a depth of from about 14 to 16 feet above the sand bottom of the cupola. If the pressure were reduced to seven or eight ounces, it undoubtedly would mean that the total depth of the charge would have to be considerably reduced and, in consequence, the rate of melting likewise would be reduced, though not nearly in proportion to the reduction in pressure, as many cupolas operate under these pressures with good results, but they invariably are equipped with low charging doors.

Panama-Pacific Carborundum Exhibit

In the machinery building at the Panama-Pacific Exposition, which opened at San Francisco on Feb. 20, the Carborundum Co., Niagara Falls, N. Y., has an exhibit space occupying an area of 1,400 square feet. The main portion of the setting for the exhibit consists of a classic colonnade with wings. The cornice work is enriched with Greek cresting and moulding and is supported by fluted columns with ornamental capitals. The wings of the colonnade form partly enclosed office spaces.

In the center of the exhibit space is a fountain with a tile basin and marble curbing. The fountain is built of irregular masses of vari-colored, irridescent carborundum crystals, piled to a height of about 10 feet. Over this mass of crystals water plays, giving a most startling effect. The floor of the exhibit space is laid with finished plaquettes of carborundum and aloxite and the four aisles leading to the fountain are floored in a Greek pattern with plaquettes of white composition, inlaid with carborundum and aloxite. Around the fountain are grouped marble urns which have been molded with carborundum wheels.

From manufacturing plants all over the world have been gathered materials which are ground, shaped or finished with carborundum products. Nearly 400 of these exhibits are shown and each contains a short description of the article and of the work done on it with carborundum products. A partial list of the articles shown, in the production of which carborundum products, in some form or another, have played an important part, include crank-shafts, automobile parts, tools, various woods sanded with carborundum, garnet paper and cloths, aluminum, gray iron, brass and bronze castings, car wheels, saws, aluminum cooking utensils, shrapnel shells, locomotive parts, drills, reamers and almost every conceivable article made from metal.

Strength of Stove Plate

By W. J. Keep.

Question:—What should be the strength of stove plate 30 inches long, 1 inch wide and about $\frac{5}{16}$ inch thick?

Answer:—The only way to find out is to test the stove plate. A tensile test probably would break the specimen at the grips. If you wish to test it transversely, you had better arrange two bearings 30 inches apart and hang a platform from the center of the plate on which weights can be piled. This test, however, would give little information of value for with good soft stove plate and careful testing you can almost bring the ends together and often the specimens will stay bent. The strength of thin, soft castings is so great and the deflection so large that results usually are misleading. The best size of test bar is $\frac{1}{2} \times \frac{1}{2} \times 12$ inches; $1 \times 1 \times 24$-inch bars also may be used. The smaller the specimen, the stronger the iron, provided the silicon is from 2.75 to 3 per cent. Tensile tests on these specimens are of no practical value. A test bar $\frac{1}{2}$-inch square and 12 inches long should have a transverse strength of 400 to 500 pounds. If you test a specimen after it has been cleaned in a mill, it will be stronger. The increase sometimes amounts to as much as 25 per cent.

Shot in Gray Iron Castings

By R. A. Pitman

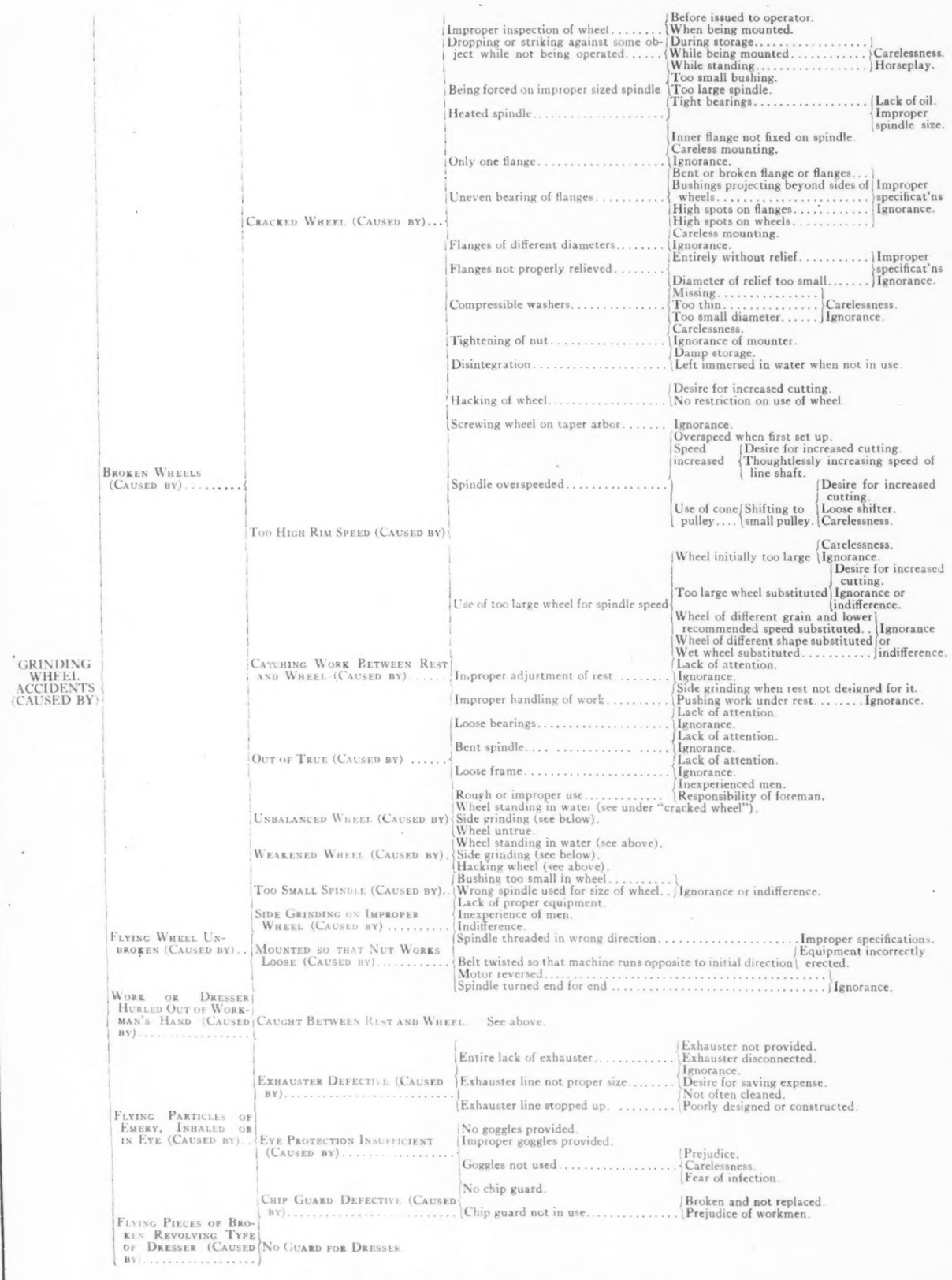
I read with interest, W. M. Carr's article on the subject of "Shot in Gray Iron Castings," published on page 52, of the February issue of THE FOUNDRY. It brought to mind some of the experimental work done by the writer while trying to eliminate some of the difficulties in the use of permanent molds. One mold in particular, gave us considerable trouble from shot in the castings produced, and this was finally traced to splashed metal as suggested by Mr. Carr.

The permanent metal mold allows vastly more opportunity for determining just what occurs between the time of pouring the casting and the time of its final solidification, than is possible with any of the usual methods of making castings. In this case, by disregarding the obvious dangers, and keeping my eye at a small opening through which I could see the interior of the mold as it was lighted up by the incoming metal, I was enabled to positively determine that the splashing metal was the cause of this troublesome shot.

This mold was rather high, and somewhat inconvenient to pour, and often a small amount of metal was allowed to fall from the lip of the ladle before the full stream was started. This spilled metal dropped into the gate of the mold and falling to the bottom, attained so much velocity that upon striking the bottom of the gate, it was broken up into many small globules which shot out in all directions within the mold, and while many of these small globules fell back to the bottom of the mold, many struck upon the sides of the mold and adhered thereto until they were either carried away or covered by the metal rising in the mold. The resulting castings showed that these entrapped globules or shot were not remelted. Chemical examination did nothing more than to confirm the information already obtained. Naturally, we did not find any increased carbon content, as mentioned by Mr. Carr, as we did not use any coating on the mold. We did find, in all cases, a small shot more or less loosely imbedded in a cavity showing the effects of the oxygen gathered up by these small globules during their flight through the air within the mold before they were captured by the rising metal, and this oxide (or carbon in the case of coated molds) is probably directly responsible for the fact that the shot is not remelted, as its coating of oxide or carbon serves to keep it from contact with the hot metal long enough to prevent its melting.

WHY YOUR GRINDING WHEEL BREAKS

HELP TO PREVENT ACCIDENTS



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Safety in Care and Use of Industrial Railways

How to Prevent Injuries in Transporting Materials in Foundries and Machine Shops and What Precautions to Observe

INDUSTRIAL railways are used quite extensively in many foundries for transporting pig iron, scrap and coke to charging floors and for conveying sand, castings and other materials in and about the shop, it is stated in a bulletin issued by the National Founders' Association. In some foundries, ladles of molten metal are carried on trucks which run on industrial railways.

In seeking to prevent injuries arising from the use of industrial railways, the condition of the tracks merits first consideration. The use of amply heavy rails will prove a safe and good investment, for heavy rails are not so easily damaged by hard usage as light ones and will wear much longer. To promote smooth passage of the cars the rails must be substantially supported at sufficiently close intervals to avoid sagging, binding or spreading of the rails and the rail joints must be well secured and in good alignment on both top and edges. Where rails connect with a turntable, cars may be badly jolted or even thrown from the track altogether if the rails do not make good connection with the turntable or if the latter is not properly latched in line or if it is in a "rocky" condition. The same is true of switches which do not afford good and certain alignment. While jarring of loads or derailment of cars, when carrying ordinary loads, may cause much injury by falling of the load upon workmen, the hazard is considerably increased when molten metal is being carried on such cars; it is then all the more important that the tracks be in good order.

Where workmen are frequently crossing industrial tracks and are apt to trip over them, or where it is necessary to wheel ordinary trucks and barrows across them, the tracks are frequently laid in concrete or set in wooden floors, with the rail tops flush with the floor, or the rails are cast as a part of rough-surfaced floor plates, laid level with the surrounding floors. When tracks are laid flush with floors, the grooves between the rails and floor form a catch-all for dirt and sweepings. These grooves must be kept clear to make movement of cars safe and easy.

Where frogs or rail guards are apt to catch and injure workmen's feet, they should be equipped with heel guards that will prevent entrance of workmen's feet to an unsafe depth.

Location of Track

The location of the track may be a source of accident unless proper safeguards are provided. This is necessary, for instance, when a car runs on a track which forms a junction with another passageway and when, because the approaching car is hidden or partly hidden by piles of materials or by partitions or buildings, it cannot be seen quickly enough to avoid collision with men walking in the passageway. It may be feasible to deflect the foot path or the track to avoid this condition, or the piles of materials or the partitions or buildings may be moved from the junction of the track and pathway, and relocated where their presence will not endanger workmen. If, however, these remedies cannot be applied it may yet be practicable to safeguard the hazard by erection of guard gates or fences across the pathway where it meets the track; this arrangement would serve to temporarily slow down the workman's pace as he approaches the dangerous point and thus allow him time to notice if the way is clear. Or the guard gate or fence may be swung across the track where it meets the pathway in order to slow down the speed of the cars themselves as they cross the junction. Such guards are especially needful where a doorway from or into a building leads directly upon industrial tracks. In every case, signs with the inscription *Danger* or *Railroad Danger* should be conspicuously affixed to the guard gates or fences.

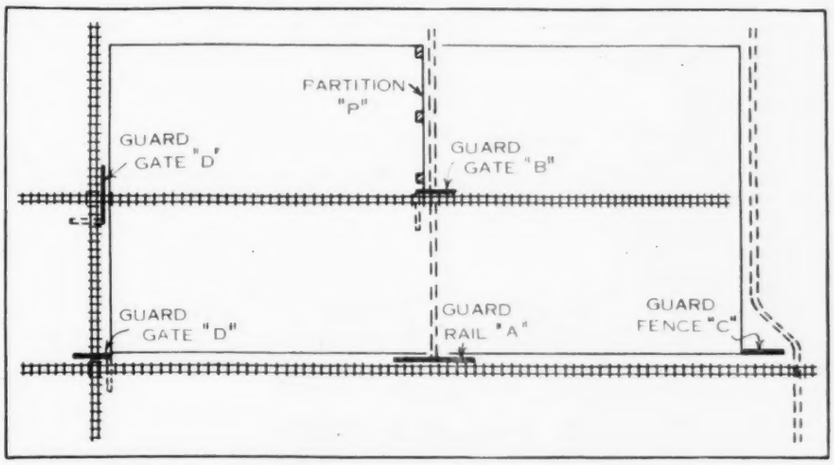

DIAGRAM SHOWING METHOD OF PROVIDING AGAINST COLLISION WITH CARS ON INDUSTRIAL RAILWAYS

Workmen walking from building must pass around guard rail A and thus take time to see if there is danger before walking over tracks. Guard gate B requires workmen walking in pathway behind partition to stop and look before crossing track; when gate is swung across track, operator must stop car to set gate. Guard gates D prevent collision at junction of tracks where building may obstruct view of moving cars until too late. Guard fence C compels workmen to walk around it and thus secure view of and avoid danger from car which may be approaching.

Installation of automatic warning gongs on cars will also help to avoid accidents. Where existing conditions make it necessary or convenient for workmen to walk on or about industrial tracks which are located alongside fences, buildings or piles of materials, ample clearance must be provided, else workmen may be injured by passing between cars and these obstructions or by scrambling over stationary cars. If safe clearance cannot be allowed, the passage should be closed to all travel except to that of the cars and of those who operate them. Here again proper danger signs will prove of great value in preventing injuries to workmen.

Switch levers should be arranged to throw parallel with rails: when switch levers are operated at right angles to rails, the switchman is apt to be struck by an approaching car.

Sometimes the nature of the work requires that workmen should stay on industrial cars when they are in motion: ample clearance must then be provided to prevent workmen from being jammed between cars and doorways or other obstructions. Coasting on cars should never be tolerated.

In some plants inclined tracks are

used on which industrial cars are propelled by cables or chains operated by a winch. Breakage of the cable or chain may precipitate an accident, and it is obvious that this extraordinary hazard warrants unusual care and constant watchfulness. The proper performance of car couplings and brakes is of particular importance on inclined tracks. It may be advisable, under some conditions, to fence in such tracks at location where loss of control may allow a car or train of cars to run down the incline. Portable rail stops or permanent automatic rail stops serve to check a runaway car or train; or blind switches may be installed at points where they will safely deflect or stop cars that have broken away from safe control.

The cars should be suitable for their purpose. This is as important from a safety viewpoint as well as upon grounds of economy and convenience. The attempt is frequently made to utilize one type of car for all kinds of service. Large, lightly constructed coke cars or sand cars are not suitable for handling scrap or pig iron; pig iron cars are not well adapted for light castings or scrap, while cars with wooden platforms are soon charred when used for transporting hot castings.

Accidents often can be traced to the handling of pig iron on cars which are too weak for this purpose or the platforms of which are much larger than the wheel base. Such cars will soon break down in service or topple over because overbalanced; often also, the pig iron will be jarred from the car and fall upon workmen's feet. The platform should not greatly overhang the wheels at sides or ends, and substantial braces should be secured to the platform ends to safely hold the pig iron even in case of maximum loads. On account of the great weight concentrated on pig iron cars they should be strongly built. Similar precautions, adapted to the particular service required of them, should be taken in regard to all cars of whatever type.

Industrial cars are frequently used outdoors where moisture attacks the woodwork, corrosion weakens the iron parts and the bearings are exposed to sand, coke, dirt and grit of various sorts. By reason of the hard service in which they are employed, such cars are subject to great wear and tear and therefore are particularly liable to cause injury to workmen on account of breakage or looseness of parts. Wear of axles, wheels or bearings may also cause poor alignment of the wheels, which may bind when going around curves, or jump the track when passing over switches or turntables. All industrial cars should be lubricated regularly, inspected frequently and kept in good order, particularly when used for handling molten metal or in especially hard service.

Wheels of industrial cars sometimes require guards or fenders. Accident records show that frequently workmen brace their feet against the track close to the car wheels, when the load is being lifted from or placed upon the car. In that case, the car has a tendency to lurch forward and crush the workmen's feet. It may be feasible to apply brakes or to wedge the car in place to prevent such accidents, but it is far safer to provide an appropriate guard on the car around the wheels close to the rails. Such a guard will prevent workmen from placing their feet on rails between the wheels, and will push workmen's feet from the rails if they are in front of the wheels when the car starts.

When an industrial car is carried on an elevator, the workman may carelessly allow the car to project over the elevator platform or the vibration of the elevator may cause the car to run off the platform. To avoid accidents resulting from such a condition it may be wise to chip or grind slight depressions

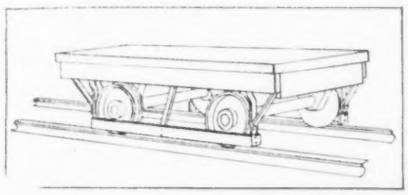

FIG. 2—CAR WITH GUARDED WHEELS

in the platform track corresponding to the proper location of the car wheels, to keep the car in its place and prevent its premature movement.

It is evident that while it is important to keep the industrial railway equipment in good order, yet the chief factor in preventing industrial railway accidents is the education of workmen to proper care for their own safety.

Slow Melting in the Cupola

By C. Metcalf.

Question:—We operate a 36-inch cupola and to melt 20,000 pounds of iron requires from 3½ to 4 hours. The bed consists of 600 pounds of coke and the succeeding charges contain 1,500 pounds of iron and 150 pounds of coke. Our coke contains carbon, 90.82 per cent; ash, 8.44 per cent and sulphur, 0.64 per cent. The first five tons melt in an hour and 15 to 20 minutes, while the succeeding five tons require from 2 to 2½ hours. After the first five tons are melted the tuyeres freeze and the cupola bridges. We use two shovels full of limestone on each of the last eight charges. Occasionally this helps to eliminate our trouble, but as a rule we experience the difficulty outlined. Our blast pressure is 11 ounces and we have a tuyere area of 3 to 1. The slag drops down to the tuyeres and will not run out of the slag hole, which is opened as soon as five tons have been melted.

Answer:—I had the same difficulty with a 40-inch cupola and to remedy it I installed four tuyeres, 5 inches deep and 10 inches long. The inner side of these tuyeres were flared to a length of 14 inches, thereby spreading the air around the entire interior of the furnace. Also four tuyeres, 5 x 4 inches each, were installed between the larger tuyeres located at a point 5 inches above the latter, thereby providing practically a continuous tuyere around the cupola. The top of the bed extended to a point 23 inches above the top of the small tuyeres and on this was added 1,000 pounds of iron. The next charge consisted of 130 pounds of coke and 1,000 pounds of iron. This was followed by two charges of 130 pounds of coke and 1,000 pounds of iron and four charges of 120 pounds of coke and 1,000 pounds of iron. The following charges contained 100 pounds of coke and 1,000 pounds of iron until eight tons of iron were charged and the last four charges contained only 80 pounds of coke for each 1,000 pounds of iron. It has been my experience that better results are obtained with small charges than with large charges of iron.

With reference to slag closing the tuyeres, I wish to state that I have never used a slag hole nor have I employed limestone as a flux. The slag is permitted to run out of the spout and this prevents it from getting into the tuyeres.

With reference to the blast pressure, 14 to 16 ounces will prove satisfactory. If this pressure is employed and if you take the iron away from the cupola as fast as it is melted, you should experience no difficulty in making your heat in 2½ hours after the iron has begun to flow. Also, the iron should be broken small, so that it will melt easily. A pig 8 inches long will melt more quickly than one 16 inches long and this likewise applies to scrap.

With reference to the use of limestone, this can be charged with each charge of iron, but I suggest that it be added to the last four charges and I know that you will obtain better results and you will reduce the amount of slag. If you will arrange your tuyeres as previously outlined, you will experience no difficulty. I can melt 15 tons of iron in three hours without a slag hole, nor do I experience bridging or hanging in the cupola.

Operating a Foundry on a Scientific Basis---V

A Discussion of the Inspection Department, With an Outline of Its Duties and Responsibilities

By Frederic A Parkhurst

ONE of the most important branches of the organization is the inspection department. Though we may have completely developed and under control our office and sales departments, a properly operating planning room, routing and controlling orders, material and labor, and a well maintained plant, these all become useless without the continual supervision of the inspection department.

Inspection must control, to the smallest detail, all of the various operations from the first inspection of the design to the completion and shipment of the last piece on a customer's order. This is particularly true when we begin to realize intense production and where, in addition to an hourly rate, we pay a large bonus for extra production. Under these conditions the most rigid inspection is necessary.

The subject of inspection will be discussed in order of the following:

A—Designing.
B—Detailed drawings.
C—Complete pattern equipment.
D—Sample cores, mold and casting.
E—Laboratory control of mixtures and pouring temperature.
F—Balance of labor.
G—Details of method.
H—Production standards based on time study.
I —Routine production inspection, including.
  a—Pattern equipment.
  b—Cores.
  c—Molds.
  d—Pouring temperatures.
  e—First inspection of casting—hot.
  f—Knockout inspection.
  g—Trimming inspection.
  h—General inspection.
  i —Final inspection.
  j—Service inspection.
  k—Inspection Committee.

FIG. 15—POURING HEAVY CASTINGS WITH TEMPERATURE UNDER CONTROL

Consideration of the design in connection with a customer's engineering department represents the first touch of inspection pertaining to that customer's order. It is oftentimes possible, by consultation with the customer's engineer, to co-operate toward a simplification of design or change of sections, or a combination of both. Two heads are better than one.

The promotion of the above method can but result in eliminating many causes for loss and delay, when the design in the form of a pattern finally reaches the foundry.

There is a double advantage following this method of preliminary inspection in connection with a foundry that has highly developed operating methods. Such methods give the designing engineer access to a great deal of data covering past experiences that cannot help but be of great advantage to him in connection with future work.

Of course the foundry's engineer is the medium through which the customer's engineer and designers get their benefit of the best foundry practice.

A more critical inspection now takes place when the detailed drawing for an individual piece is ready for the pattern shop. At this stage we have to consider a great many different things that we but superficially touch upon when the general designing inspection was made.

Before proceeding with the pattern equipment there are a great many things to consider. These different

A paper presented at the joint session of the American Foundrymen's Association and the American Institute of Metals, Chicago, Sept. 9, 1914.

items include, quantity to be made from a pattern, foundry method to be employed, cost of the pattern equipment for various molds where a choice is possible, method of rigging up, gating, flask equipment, etc.

If the pattern under consideration is a cored job we have to consider the style and arrangement of core boxes. This brings us down to a minute consideration of the design and proportions of the pattern. This inspection often leads to a modification in design or proportion overlooked at the time of the first inspection.

When considering the matter of equipment the members of the factory board are often represented in a discussion as to these details. It is also important that the superintendent, time study foreman and foundry foreman should work together toward a settlement of these preliminaries.

Too much stress cannot be laid on the fact that pattern equipment (excepting perhaps in relation to large production jobs) does not as a rule have the careful attention that it should. The average foundry does not know what is the best combination of flask dimensions (based on scientific knowledge) to get the greatest tonnage from a given pattern. This statement applies to jobs which may be run from either a solid or split pattern, or a gated pattern, or a plated pattern. In other words, there is an ideal combination for every job. These jobs cannot be intelligently and economically planned, and pattern equipment cannot be properly made without the accurate standard data and production knowledge which can only be determined by scientific methods.

On bench and squeezer work we have also to consider those jobs which require matches. The design of the match and method of its construction have a very material effect on the job when it reaches the foundry.

A consideration of the items above gives us the full knowledge to prepare our complete pattern equipment. This pattern equipment, as the term is used, means not only patterns and core boxes but core dryers, matches, etc. Where the flask equipment is special and the patterns cannot be adapted to standard flasks and boards, then this equipment should also be considered as part of the pattern equipment—likewise machine equipment.

The machine equipment, the standard and often used for many jobs, represents part of a given pattern equipment, provided such equipment is designed to run on that machine.

At all stages of the work through the foundry continual inspection must be maintained of core boxes, dryers, pattern equipment, flasks and machines. If this inspection becomes lax we may continue to make cores which the molder has to file a bit or we may be tied up for production due to lack of a certain number of core dryers. In other words, there is much more to the subject of inspection of pattern equipment than merely the inspection of a new pattern. This inspection must be continuous—patterns must come out of the sand at night, be inspected and perhaps "touched up" before production starts in the morning. The flasks must be watched to see that there is no shift in the pins—core boxes must be examined periodically to see that loose pieces do not "ram off" or become misplaced due to wear or distortion.

Regular shop inspection or work produced first takes place at the time sample castings are made. Here we have to consider the inspection of cores, mold and casting. The cores should be inspected in the core room and when necessary, gages should be provided to assist in inspection as to size and shape. When making sample castings it is well to order two or three sets of cores. This method will expedite making of samples in the event the first one or two castings are lost.

The inspection of the mold is the next step. This inspection should take place before the mold is cored up. At this point we have to consider the action of the pattern to see that it draws properly. If the pattern

FIG. 16—TRIMMING AND INSPECTING ROOM WITH A CAPACITY OF 50,000 POUNDS OF ALUMINUM CASTINGS PER DAY

does not have proper draft or if there is something wrong with the rigging we have a torn-up mold. This should be corrected at once and another mold tried out until we get the pattern working in satisfactory shape. When we have a perfect mold we are then ready to provide a necessary gating, after which the mold is ready to core up.

In setting cores in the first mold every core should be carefully inspected as to size and fit. The "setting" must be inspected to see that the core prints and cores match properly—that the core settles into position and that we have a proper thickness of metal as per the blue print. A detail blue print of the piece in question should be on the floor at the time the sample casting is made. This is particularly important where the job is a large floor job or a complicated piece.

Based on past experience by consulting records of pouring temperatures of similar castings the correct pouring temperature for the first casting will be determined. After the mold is poured and dumped out an inspection of the casting will indicate as to whether the mold was poured at the correct temperature or not. Of course, this may not become definitely known until after the cores are knocked out and the casting chipped.

In any event the one or two castings which are poured first will allow us to determine the correct pouring temperature. When this has once been determined all of the subsequent castings will be poured at that temperature, within an allowable variation of a few degrees, as shown in Fig. 15.

The sample as soon as poured should be "knocked out", passed through the trimming and inspection departments, Figs. 16 and 17, and checked by the chief inspector to see that it agrees with the drawing. After this has been done it is ready for delivery to the customer provided it is passed in quality, workmanship and size by the chief inspector. All sample castings are marked with a tag and directed to the attention of the party at the customer's plant who is to give it the first inspection and O. K. A written approval of the sample casting is required before the foundry proceeds with production.

Prior to the pouring of the casting laboratory control exerts its influence. In other words, the mixture is determined and the laboratory control of melting and pouring assures the best practical results in the pouring of the casting itself.

All molds are poured by a specially trained gang. The pouring gang as well as the furnace men and melters are under the general supervision of the chief chemist insofar as the technical part of their work is concerned. By this method we eliminate labor and delays caused by the molder pouring his molds himself. We are also able to restrict the responsibility for a proper melting temperature and pouring to technically trained men rather than to the average run of untrained mechanics.

Laboratory control as above described in itself represents another very important form of inspection. In other words, through laboratory control we have a study of alloys and inspection of mixture and pouring temperatures.

The balance of labor is pre-determined by our time study foreman and our standard production data. When production is realized, based on given equipment, and a check on the quality of the work turned out, it gives us a continual check on our labor. The "man days" worked on a given production at a prevailing average rate per man day for different classes of labor, checked against our cost control chart gives us the equivalent of an inspection control on all labor expended.

In addition to the general labor control, as explained above, we have the detail inspection of method. This inspection of method consists of the detailed time study into the motions and times of operations. All standard operations are made up of sub-operations or elemental sub-operations. The elemental sub-operations have been standardized and standard times determined for them. These determinations provide for certain combinations to meet any of our standard methods.

The inspection of equipment and the determination of the method combined with our standard production data gives us a perpetual control and inspection of these methods while each job is in process.

After determining the balance of labor in the detailed method described above, the time study foreman issues the necessary instructions and bonus charts to cover the details of the job in process. As mentioned, our standard data give us the basis for all of this information, though certain individual time studies may be necessary to take care of any special features peculiar to that job.

This time study work includes the time study necessary to put on bonus core making (each individual box is figured separately), molding, knocking out, trimming and inspection and any other operations involved in the process.

We have discussed the various divisions of work necessary to get a foundry job in condition to run. After the submission of the sample and a written O. K. from the customer we are then prepared to run the job on a production basis. The routine inspection of the job while it is in process for production is very similar to that outlined above. In other words, to sum up the above we have

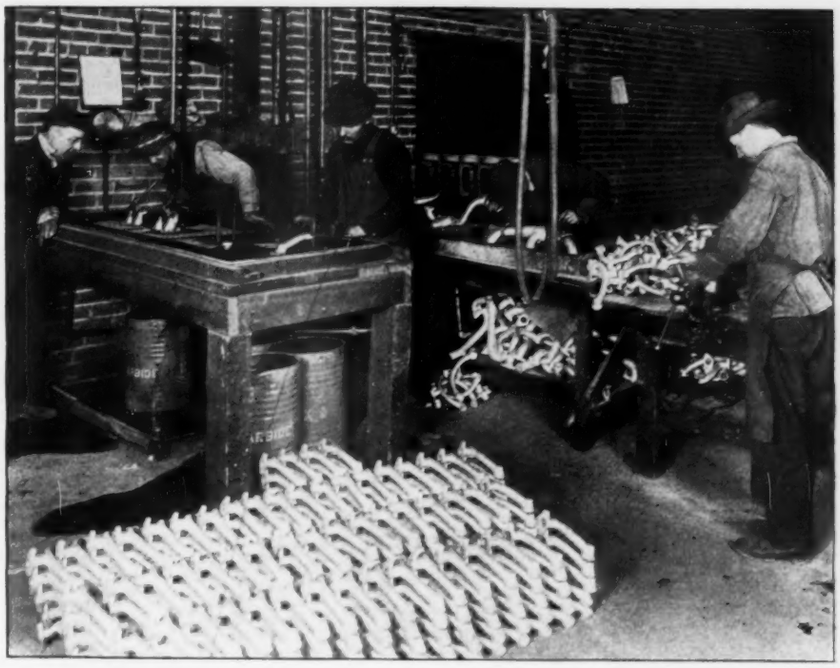

FIG 17—HYDRAULIC TEST AND FINAL INSPECTION OF INTAKE MANIFOLDS

during production the following stages of production, viz.:

a—Pattern equipment.
b—Cores.
c—Molds.
d—Pouring temperature and laboratory control.
e—First inspection—hot casting.
f—Knockout inspection.
g—Trimming room inspection.
h—General inspection.
i—Final inspection.

Applying to certain of the above stages of inspection we must, of course, have drawings, gages or other standards to which inspection shall be made. The use of gages is desirable in both core and molding rooms. They are also equally desirable in many cases in the trimming and final inspection rooms, although the entire field under discussion is considering only rough castings, not machining operations.

Careful Inspection

As stated at the commencement of this section on inspection it is absolutely necessary that the various stages of the work in process shall have careful inspection along the lines indicated above. There can be no economy in a delayed core inspection with the resultant loss of a lot of cores; nor a delay in the first "knockout" inspection when the casting is hot. The foundry is liable to run ahead with a large production before the defect becomes known. Often defects will be discovered after the casting has reached the trimming table. Oftentimes there will be a strain in the casting which, though not sufficient to break it at once, will cause it to fracture under the ordinary vibration it gets in knocking out cores and during the process of trimming. Here we have a defect, the discovery of which was delayed.

Prompt action is necessary to report all defects back to the molding room or the laboratory, as the case may be. Sometimes a slight difference in the run of metal will cause a crack and it is up to the laboratory to immediately run down this trouble.

We must realize the necessity for continuous control of operations, particularly where the men are working at high speed and are making large bonuses. When men have been trained to do their work with a minimum of motion and exertion, keeping their minds and hands continually on the job, with proper inspection control the required production can be realized with an A-1 quality. This statement is not based on any theoretical proposition but on absolute facts and experience of years. The writer has one large foundry in mind where his methods tripled the production and reduced the defective loss 60 per cent.

We now come to the last word of inspection service, viz.—the service inspector. The success of service inspection depends primarily on two things—one the inspector himself, the other the plant behind him. The service inspector, while primarily a shop man by training and experience, should be a member of sales department when the ultimate scheme of organization is complete.

It shall be the service inspector's duty to keep in touch with all of the customers, particularly the large ones, so as to learn as early as possible all of their complaints. He must, of course, keep in touch with the foundry during his daily trips. This is particularly true where continuous pouring is the practice and the foundry is run solely as a jobbing business.

If the service inspector is a practical man he can go into the customer's plant and co-operate with the customer's inspectors and mechanics. His service will prove to be one that is mutually beneficial. It is only too true that complaints based on some small minor trouble or defect often reach "those higher up", which if given prompt attention in the first place by the foundry would never have developed into a complaint at all.

The more thorough knowledge a foundry has through its service inspector of the requirements of the customer, the accuracy he requires, the better the service. Service inspection is necessary too so that the foundry can tell just what part of the work must have particular attention and be held to close limits and what part will stand a greater allowance of variation.

The writer believes that the average reader will agree with him when he states there is too little harmony between the average foundry and the average machine shop. Each thinks the other is wrong. It is undoubtedly true, however, that the foundry and machine shop heads are oftentimes not sufficiently familiar with each other's trades to allow them to work together to the best advantage. Where this condition obtains the service inspector, though perhaps in an unenviable position, has the opportunity to make himself doubly valuable. The advantage of such a service is obvious if the right man is chosen for this most important position.

Results Obtained Under the Above Methods

Table V, published in the previous installment, indicates the result that can be expected by the proper application of the methods described above. More than 400 operations are listed. At the present time bonus data has been issued for about 2,000 operations. All of these operations are based on time studies. In addition to the operations mentioned above 1,656 standard bonus charts have been established. These standard charts are applicable to over 36,000 combinations of bench and squeezer work. This data covers 95 per cent of the work done by any of the six foundries of the Aluminum Castings Co.

The average saving in cost of production, production increase and increase in the average wages is as follows:

	Per cent.
Production increase	206.8
Cost reduction	58.0
Wage increase	28.9

There is, of course, a certain amount of added overhead in connection with the type of organization described above. The percentage of increase is small, however, compared to the net saving in total cost of turning out a given product. In the last analysis the question is—what saving in total cost can be realized by the adoption of scientific management? The writer's experience justified him in placing this figure at 25 per cent to 35 per cent. These are figures which he has realized in practice and are not based on guess work.

Stove Plate Iron

By W. J. Keep

Question:—We operate a stove foundry and our pig iron analyzes silicon, 3 per cent; sulphur, 0.03 per cent; phosphorus, 0.62 per cent and manganese, 0.70 per cent. What percentage of pig iron and scrap should be used in our mixtures? Also let us know the approximate cost per hundred pounds for molding, milling and grinding and melting and also the percentage for discount and breakage.

Answer:—Your mixture is ideal for stove plate except that the phosphorus should be close to 1 per cent to give the iron fluidity. If you melt the iron sufficiently hot you will not notice the low phosphorus percentage. You should use at least 40 per cent of your own scrap. If the phosphorus in your iron is 1 per cent and if you can keep the sulphur in the castings as low as 0.075 per cent you might use foreign stove plate scrap in the proportion of 100 pounds to each 1,000 pounds charged. The molding cost should be $1.25 per hundred pounds, milling about 40 cents, grinding about 90 cents and melting about 8½ cents. The cupola labor should cost you about 5 cents per hundred pounds. The discount should average 5½ per cent and the breakage about 3 per cent.

THE BRASS FOUNDRY

Brinell Hardness-Testing of Non-Ferrous Alloys

By V Skillman

AMONG the more important physical tests to which non-ferrous alloys are submitted there is one which, until recently, has received comparatively little commercial application. Although the hardness of a metal is often of considerable importance to both the manufacturer and engineer, it usually is classified by stating that it is hard or soft without reference to any definite method of measuring that quality. Naturally, the result depends largely upon the personal view of the observer. If the machinist classifies an alloy as hard, the engineer will quite likely find its resistance to compression or indentation is not such as would lead him to call it hard.

Considerable of the confusion is the result of the difficulty in defining hardness. It seems at present impossible to use any scientific unit to express hardness and quite different meanings are embraced by the one general term. As the result of such a condition the methods devised for measuring hardness have been the outgrowths of attempts to obtain data with some particular idea in view in each case. The numerals found are, therefore, empirical and depend upon the method used in their determination.

Hardness Tested by Scratching

One of the oldest methods of determining hardness is to ascertain the amount of resistance to scratching. This is the method of the mineralogists. Means have also been devised for its application to metals.

Other methods measure the compressive hardness by determining the resistance offered to indentation by another body. A measurement of the elasticity is made use of in some methods, while in others toughness and abrasive qualities are brought into prominence in determining the cutting hardness.

Of the many methods developed, several have lately come into prominence on account of the possibility of their commercial application. One of these used extensively is that devised by Brinell. It is dependent upon the resistance offered by the sample to indentation. The test consists of pressing a hardened steel ball into the surface of the sample being investigated, by means of a definite load and measuring the diameter of the resulting indentation. The hardness numeral is the ratio of the pressure on the sphere to the area of the spherical indentation.

The test can be made in any form of apparatus capable of pressing the ball upon the surface of the metal and measuring the pressure exerted. In the absence of a special piece of apparatus the test may be made with considerable accuracy in the average small size tension-compression testing machine. The machine is arranged as for a compression test, and the steel ball is fastened to the under side of the pulling head as near the center as possible. It is better if it is not fastened to hardened steel, as it will more readily form a seat for itself when making the first impression. No elaborate device is necessary to hold the ball if the specimens to be tested are mounted fairly level as they should be. A piece of tar or similar material is all that is required to hold the ball in place.

The test is best made by first bringing the ball just in contact with the face of the specimen. The weight on the machine is then run out to a hundred pounds or so less than the load finally desired. Pressure is next applied until the beam floats using one of the higher loading speeds. The weight is quickly advanced and set accurately at the full load to be applied. The slow speed of the machine is then used to float the beam, and keep it floating during the time required for the test.

It probably is sufficiently accurate to figure the time, which the piece is subjected to pressure as beginning when the beam first rises as the greater part of the load is then operative. After 30 seconds, or 15 seconds if the 3,000 kilogram load is being used, the pressure is released and the diameter of the indentation measured in millimeters.

It has been found that after a little practice with a fairly sensitive testing machine, results can be obtained which check very well with determinations made on Swedish apparatus.

Standard Methods

In making the Brinell test it is exceedingly important that what may be recognized as a standard set of conditions be followed. Most of the data so far published has referred to ferrous material. Much of that which has been obtained on non-ferrous alloys would often have been of more general value and application if the conditions suggested by Brinell had been followed in making the tests.

It has been recommended that a standard ball of 10 millimeter diameter be used with loads of 3,000 kilograms for ferrous materials and 500 kilograms for non-ferrous alloys. It also is advisable that iron and steel samples be submitted to the pressure for 15 seconds and alloys for about 30 seconds. The factor which has the greatest influence on the numeral obtained is the pressure applied. It has been found that elastic deformation of the sphere used is produced by the load. It is relatively greatest at the lowest pressures. Under such loads the indentation is small and the resistance offered is all in the direct line of the pressure applied. There is practically no lateral component tending to make the sphere retain its shape as when heavier loads are applied and the indentation is likely to be greater.

If the depth rather than the diameter of the indentation produced were measured, the size of the load would not be of as much consequence. It is quite likely that a linear relation exists between depth of indentation and load. It is, however, more diffi-

From a paper presented at the Chicago, 1914, convention of the American Foundrymen's Association.

cult to measure the depth than the diameter of the indentation, and the latter is now almost exclusively the measurement made in commercial work.

Under all conditions the radius of curvature of the indentation is greater than the radius of the sphere. The amount varies, however, depending upon the alloy.

Table I gives the results of tests made with two different loads, each pair of determinations being made on the same sample. The hardness number was determined by reading the diameter of the impressions.

The figures in Table I illustrate the necessity of either following adopted standard methods of testing or stating the conditions under which the test was made and especially the load applied.

Diameter of Ball

The diameter of the ball used does not seem to affect the test greatly, nor does a variation in the length of time the load is applied. It would seem preferable, however, especially in the absence of more detailed information concerning their effect on the test as applied to non-ferrous alloys, to follow standard methods.

Judging from the similarity of the compression and Brinell tests, it would appear that the length of time the load is applied would have some little influence on soft materials such as white metals and babbitts, which are inclined to flow under compression.

Table I.

HARDNESS NUMERALS OBTAINED WITH DIFFERENT PRESSURES.

Alloy.	How Cast.	Hardness under 500 kg. load.	Hardness under 3,000 kg. load.
Phosphor Bronze, 10 Sn	Chill	86	107
Phosphor Bronze, 20 Sn	Sand	158	196
Phosphor Bronze, 10 Sn, 10 Pb ..	Sand	50	69
Phosphor Bronze, 10 Sn, 10 Pb ..	Chill	80	103
Gun Bronze, 10 Sn, 2 Zn ...	Sand	70	82
Gun Bronze, 10 Sn, 2 Zn ...	Chill	86	107
Manganese Bronze	Sand	109	137
Manganese Bronze	Chill	119	143

It almost surely would if the load were applied for five minutes as directed in one recently published handbook, which gives directions for making the Brinell test.

Besides the variables due to the manner of testing, there are also those introduced by the sample. The effect of casting conditions upon the tensile strengths of alloys is becoming quite well known. The hardness is effected by many of the same factors.

One of the most noticeable influences is the diminution of grain size due to chilling or to *skin effect*, with a resulting increase in hardness. A large casting of red brass showed a hardness of 43 to 48 when tested inside a heavy section. The skin on a section ¼-inch thick, of the same casting, had a hardness of 70 to 80.

Chilling Phosphor Bronzes

As in the tensile test, chilling seems to have the most influence on the hardness in the phosphor bronzes. These same alloys are decidedly influenced by the temperature of pouring and the resulting rapidity of solidification. A phosphor bronze containing 20 per cent tin gave a Brinell hardness of 100 to 109 when poured hot. The same pattern of test piece poured cold from the same pot of metal gave 158. Compression tests showed a permanent set of 0.070-inch per inch under a load of 100,000 pounds per square inch for the hot poured material and 0.024-inch per inch for the cold-poured. Test bars cast in size and pulled without machining gave 23,800 pounds per square inch tensile strength for the former and 35,000 pounds per square inch for the latter. The Brinell test offers an excellent means of judging the quality of such material without going to the trouble of making compressive or tensile tests.

It is evident that the hardness of a certain alloy cannot always be expressed by one definite Brinell numeral. The best that can be said is that it usually has a hardness between certain limits depending much on the particular sample selected for test. It would be well if some standard form of test specimen could be agreed upon. The end of the cast-to-shape test bar has been found convenient by the author for comparative work.

Some idea of the hardness of a few common brass foundry alloys may be obtained from Table II. The determinations were made with a 10 millimeter ball and a pressure of 500 kilograms applied for 30 seconds. The sand cast data were obtained by using the ends of cast-to-shape test bars, and the chill cast data are from sections of small ingots cast in an iron mold.

The relation between Brinell and scleroscope hardness determinations would often prove useful if it could be fairly accurately determined. It is at times stated that to change from the Brinell number to the scleroscope reading, the former should be divided by six, and the scleroscope number multiplied by six gives approximately the Brinell numeral.

Such directions may hold for ferrous material where loads of 3,000 kilograms have been used for the Brinell tests and the universal hammer was used with the scleroscope. They do not hold, however, for non-ferrous alloys tested under 500 kilogram loads and with the magnifier hammer in the scleroscope. Further, it does not seem likely that any one factor will be found to apply for all classes of non-ferrous alloys.

The hardness test is capable of considerably wider commercial application than it has so far received. Much useful information can be quickly gained by its aid, but in order to avoid confusion and possibly self-deception, it is necessary to be familiar with the more important conditions which influence the results.

Table II.

UNUSUAL HARDNESS OF SOME COMMON ALLOYS.

Alloy.	Hardness under 500 kg. cast in sand.	Hardness under 500 kg. cast in chill.
Phosphor bronze, Cu 90, Sn 10.....	67-70	93-100
Phosphor bronze, Cu 80, Sn 20.....	143-158	.....
Phosphor bronze, Cu 80, Sn 10, Pb 10.....	65-70	80-89
Gun bronze, Cu 88, Sn 10, Zn 2.....	65-74	86-93
Composition, Cu 85, Sn 5, Pb 5, Zn 5.....	48-59	63-67
Yellow brass, Cu 69, Sn 1, Zn 30.....	54-59	59-65
White brass, Sn 66.5, Zn 29, Cu 4.5.....	19-20	22-23
S. A. E. Babbitt, Sn 84, Sb 9, Cu 7.....	.....	26.5-30.5
Manganese bronze.....	109-119	124-130

Practical Hints for the Brass Foundryman

By P. Micks

1.—Season all new crucibles thoroughly before using.

2.—Charge the flux with the first metal placed in the crucible.

3.—Feed cold metal slowly into the melted mixture and do not force it.

4.—Watch your scrap closely, as much of it contains lead and iron which will cause trouble.

5.—Use first class molding sand and you will find it the cheapest in the end.

6.—Always keep an eye on the furnace, as the best of metal frequently is ruined by not exercising the proper care while it is being melted.

7.—Do not pack your crucible too tight when remelting scrap, as the expansion of the metal when heated often will split the pot.

8.—Charcoal is the best covering for your metal, as it contains neither sulphur nor hydrocarbons and produces the proper atmosphere for protecting the metal.

9.—See that all of the flasks are in repair and that they are provided with tight pins and have level joints.

10.—Test all new mixtures before shipping the castings, as this will save time and trouble for your plant and for your customer.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Use of Phosphor-Copper

Several days ago I made some bronze gas and water meters, using the following mixture: Copper, 100 pounds; tin, 10 pounds and lead, 6 pounds. These castings did not turn out satisfactorily, some being honeycombed, and also the black scale from the copper appeared in the castings. I have overcome this to some extent by using one tablespoon of plaster of Paris and one tablespoon of salt, putting this in about 15 or 20 minutes before taking the pots from the furnace. Can you suggest anything better?

The addition of 2 per cent of phosphor-copper to the alloy will improve it materially. The mixture then would consist of the following: Copper, 98 pounds; tin, 10 pounds; phosphor-copper, 2 pounds and lead, 6 pounds. The honeycombing was caused by oxidation and the phosphor-copper will have a tendency to prevent this. The black scaling did not come from the copper, but was caused by iron which must have been mixed with the scrap copper used in making the alloy. If clean, bright castings are desired, clean metal must be used, such as trolley wire, ingots or heavy, cut copper.

A much better mixture for the purpose outlined follows: Copper, 87 pounds; tin, 6½ pounds; zinc, 3½ pounds and lead, 3 pounds.

Casting Brass Onto Iron

Kindly advise us if it is possible to cast brass onto the side of a locomotive driving box, using the latter as the bottom of the mold and anchoring the brass with studs and dovetailing. In cooling, would the brass shrink away from the anchors? We have been informed that eastern railroads do this work in this way.

If the iron is expanded by heating before the brass is run into place, the castings can be made successfully. It occurs frequently that brass or bronze bushings are to be cast around steel shafts, the latter sometimes being very large. No difficulty is experienced from the brass cracking provided the shaft is heated to a point slightly below a dull red before it is placed as a core in the mold in which the brass is to be cast. In such cases it is good practice to flow-off a considerable amount of brass to increase the temperature of the iron. A similar method of procedure can be relied upon to give good results in your case.

There are several features to be observed to insure success, the most important of which is the removal of all rust from the surface of the iron to be covered by the brass; another is to gate the casting so that the metal will run over the iron and will rise to fill the mold and then flow-off through a riser. Hot metal should be used to pour the molds.

Melting Manganese Bronze

Kindly advise me whether it is possible to melt manganese bronze in an oil furnace as satisfactorily as by the use of coke.

The only advantage that a good pulling natural draft, coke-fired furnace possesses over an oil-fired furnace is that the operation of the furnace is conducted more quietly. There are no swirling air currents in the coke furnace which make it impossible to retain a charcoal cover on the surface of the molten metal. In melting copper alloys it is essential that the surface be protected while in the molten condition and this usually is accomplished by adding charcoal.

In a coke furnace the charcoal remains on the metal, neither burning away to any great extent nor being blown off. In an oil furnace, on the other hand, the flame generally forms a vortex of which the crucible is the center and the swirling gases unite above the crucible and sweep away the charcoal cover or rapidly consume it. The metal thus is left bare and is exposed to the gases, absorption taking place. However, if this is guarded against, there is absolutely no reason why an oil-fired furnace should not produce as good castings as a coke-fired furnace. It is apparent, therefore, that if a charcoal cover cannot be maintained for any reason, some other covering material should take its place. Green bottle glass will meet these requirements, but it should be sufficiently thick to cover the surface of the metal and if very fluid, the addition of sand will thicken it for easy skimming. Some concerns prefer oil furnaces for melting manganese bronze.

Difficulties With Aluminum Match-Plates

Ordinarily we experienced little difficulty in making aluminum match-plates, but lately we have had considerable trouble with a certain type in which the pattern forms a heavy mass of metal in the center of the plate. The dimensions of the plate are 20 x 14 inches and ¼ inch thick. The pattern forms a segment of a circle 15 inches long by 6 inches and 1 inch thick, and is located near the center of the plate. The plate is cast with the largest mass of metal in the drag of the flask and we find that the pattern shows considerable concavity in the center when the straightedge is laid across it. We are unable to correct this difficulty by the use of chills in the drag, owing to the fact that the face of the pattern is corrugated. In the cope the flat spots on the pattern are chilled with pieces of cast aluminum about ¼ inch thick. The mold is poured with two gates and is tilted at an angle of 6 inches. Kindly let us know whether it is necessary to use either chills or risers in making these match-plates and if so, let us know where they should be placed. What is the best flux to use and let us know whether we can use any alloy that will shrink less than No. 12.

This difficulty is due entirely to shrinkage and can be overcome only by the use of risers to feed liquid metal to the heavy section of the plate as it shrinks. We would suggest that the method of molding be reversed, the part that is now the drag being made the cope and a heavy riser should be taken off the bowed side of the pattern directly on the plate. The objection to this riser, of course, is that it will be difficult to remove from the plate and that it will entail considerable labor. However, this difficulty can be obviated entirely by the use of a flat core on the plate underneath the riser. When molding the plate, arrange a flat core print, approximately 4 inches long by 3 inches wide, against the convex side of the pattern; cut the core print to fit the bevel of the pattern and make a flat core to fit the print. Place a riser 2½ inches in diameter centrally on top of the flat core print and finish the mold in the usual manner. When the cope is removed from the pattern the

riser is connected by a heavy gate to the adjacent section of the pattern and then the plate core is placed in its print covering the riser. The core will have to be pinned in place so that it will not drop when the cope is being closed. The plate may be gated as at present, but the aluminum should be poured cool, at a silvery and not a red heat. This will give a smoother casting. The riser head should be built-up 6 inches higher than the top of the flask and when the sprue is filled cover with sand, bed thereon a flat weight and fill the riser, pouring slowly.

Use fine sand for facing the mold; mix the sand with molasses water and skin-dry. If the castings can be made without chills on the flat side, a finer casting will result, and by feeding with a riser, chilling should not be necessary. Since the riser is not attached to the plate itself, it can be easily removed with a hack saw.

No. 12 aluminum is a good casting alloy and is not injured by heating to a cherry red, although it is not good practice to do this. The best flux for aluminum is zinc chloride, a little of which may be scattered on the molten metal and stirred around. If the metal becomes red, a little salt can be used in place of the zinc chloride, although the latter is to be preferred.

Bright Surface on Brass Castings

We are making small brass castings which are to have bright surface and we have noticed that several manufacturers of small brass parts apply some kind of a coating which seems to be in the form of a plating. We would like to know how this bright surface is obtained without buffing.

If the castings appear to have been burnished they undoubtedly have been tumbled with steel balls and to obtain the same results it is necessary to employ a small, hexagon tumbling barrel which runs in a watertight tank. The tank is filled two-thirds with soap water made by the use of a good grade of vegetable oil soap and the tumbling barrel is filled about one-fourth with steel balls, such as are used in the bearings of bicycles. These balls are about ⅛ inch in diameter and are known as seconds. They will last indefinitely provided they are kept free from rust. The castings are charged into the barrel on top of the balls and the barrel then is rotated for periods varying from 15 minutes to an hour or more, when the castings will appear as if they have been burnished. Small steel punchings also are used in these barrels in place of the steel balls, but because of their softness and angularity the result obtained is inferior to that following the use of steel balls.

The Remelting Problem

In melting surplus metal from a previous heat which consists of all new stock, such as copper, tin and phosphor tin, would the same results be obtained as when the new stock was previously melted? What are the chemical contents of phosphor tin?

Better results should be obtained from metal that has been remelted than from the first melt because the metal is rendered more homogeneous by second fusion. For this reason gun metal, manganese and aluminum bronzes are frequently pigged on the first melt and are remelted to be run into castings. Care in melting, of course, is essential to success in making an alloy of copper with other metals. The surface of the alloy should be protected as much as possible from the furnace gases and this can be accomplished by the use of a cover of charcoal or one of the various fluxes used for this purpose. The metal also should be poked down into the pot with a suitable stirrer, such as a carbon rod. Frequently, in remelting small gates and runners they occasionally will float on the charcoal and will slowly melt away, leaving an oxidized shell which ultimately is stirred into the bath and introduces a large percentage of oxide.

Phosphor tin should contain only tin and phosphorus. Banca tin runs 99.95 per cent pure and billiton 99.96 per cent. Iron is the greatest impurity in banca tin and copper in billiton tin, with an occasional trace of lead. Therefore, if lead is present in the phosphor tin it can be assumed it was added to cheapen the product and while it can do no harm in some classes of work, it is an undesirable impurity in high grade castings. The phosphorus content usually approximates 5 per cent, but phosphor tin can be made that will analyze approximately 10 per cent phosphorus.

An Anti-Acid Metal

We would like a formula for anti-acid bronze that will withstand a high pressure as well as a great deal of friction. The fittings that we desire to make from this alloy will be subjected to sulphuric acid at a high pressure. We are familiar with the various formulas for anti-acid bronze, but none seems to stand up satisfactorily on account of the friction and high pressure.

The useful metals have been divided by chemists into two groups with respect to the action of sulphuric acid on them. The first group consists of silver, mercury, copper, lead and bismuth and the second group consists of manganese, nickel, cobalt, iron, zinc, cadmium, aluminum, tin, thallium and the alkali metals. The metals of the first group are acted upon only by hot sulphuric acid and in the case of copper, the acid should be diluted with water. The metals of the second group react with sulphuric acid of any concentration at any temperature. It follows, therefore, that nickel, iron, aluminum and zinc should not be used for parts that will be exposed to this acid. Fortunately, copper has some resistance to sulphuric acid as it is the only metal that can be used because lead, bismuth, mercury and silver are not commercially practical and are not of sufficient strength for castings. Inasmuch as copper is too soft to withstand high pressures or friction it must be alloyed and as there are no metals of the first group suitable, we must fall back on the second group and naturally will select tin. As a copper-tin alloy is difficult to cast so as to withstand a high pressure, a third metal must be alloyed therewith. However, a metal must be selected that will not really alloy, but which will be held in suspension, filling up any minute cavities that may exist in the alloy. This metal is lead and therefore the best metal that can be used will consist of copper, 88 pounds (use arsenical Lake copper); tin, 10 pounds; lead, 2 pounds and 15 per cent copper, 25 grams.

Soldering Mixtures

We would like to have mixtures for the following solders: For soldering aluminum to brass, aluminum to iron and aluminum to aluminum. What are the best fluxes that should be used?

It is not necessary to use a special solder for each metal to which it may be desired to solder aluminum. Any of the following alloys may be used for the operations mentioned.

Tin, 29 parts; zinc, 11 parts; phosphor-tin, 1 part and aluminum, 1 part.

Copper, 1 part; zinc, 3 parts; tin, 6 parts and aluminum, 2 parts.

Zinc, 25 parts; tin, 29 parts and aluminum, 6 parts.

Fluxes generally do more harm than good in soldering aluminum, as they decompose and dirty the surface to be soldered. The first operation is to tin the aluminum, which is accomplished by heating the latter and rubbing on the solder, which is in the form of sticks. The rubbing operation scrapes away the film of oxide covering the surface of the aluminum and covers it with a film of solder before it can reoxidize. This is a difficult operation, but if the solder can be made to adhere, the two pieces of aluminum can be sweated together. When aluminum is to be soldered to brass, bronze or iron, the latter metal should be tinned in the usual manner with half-and-half solder and then sweated onto the tinned surface of the aluminum.

Selecting Grinding Wheels for Foundry Use

The Abrasive Problem for Casting Work is Discussed in All Its Phases and Practical Suggestions Are Made

By Carl Frederick Dietz

THE development of the modern grinding wheel has been simultaneous with the development of the modern foundry. It would be impossible to conceive of a foundry with the melt running into hundreds of tons, removing the fins and spurs of its castings by means of chisel and file. A grinding wheel is both in one—a massive aggregation of little cutting tools bonded together in such a manner that their high speed of rotation provides an opportunity for the rapid and economical removal of large quantities of metal, doing in a few moments what could only be accomplished by endless manual labor with hand tools, if indeed at all. It required years of patient study of abrasives, bonds, burning conditions and the many other factors entering into its construction to develop this tool, with the result that, while in general appearance the modern article is not unlike that made a quarter of a century ago, it is an advanced product, calling upon the services of skilled engineers from the time the raw material is mined, through the stages of its conversion in electric furnaces into an artificial abrasive of high purity and uniform quality, and its final preparation and bonding into a homogeneous mass wherein the best skill and cunning of the ceramist is called upon to verify the bonds to a degree of nicety hardly attempted even by the makers of the world's finest pottery.

Although the grinding wheel made by the vitrified process has the greatest interest for the foundryman, many other bonding materials are used, notably the organic mixtures employed in the manufacture of elastic or vulcanite wheels, and the salts which are used in the construction of silicate wheels. Grinding or snagging of castings must by the very nature of the operation, be classed as rough work, which fact immediately establishes, in a general manner at least, the type of wheel to be considered, from coarse to medium in grain, and hard in grade.

The characteristics apply to practically all foundry wheels, whether the material to be ground is steel or its alloys, cast or chilled iron, brass, bronze or any other product.

The specific combination of grain and grade as well as the abrasive material itself is controlled by many factors. Grain and grade are influenced by

1.—Speed of wheel.
2.—Condition of machine, whether massive and rigid or light and shaky.
3.—Contact, large or small, of course with reference to its dressing action upon the wheel.
4.—Method of application, whether floor stand, swing frame or flexible shaft grinder.
5.—Ability of operator, whether trained to consider the wheel a valuacutting tool or not.
6.—Character of material, hard or soft, high or low tensile strength.
7.—Finish required, whether rough surface as left by a coarse wheel is satisfactory or whether a smooth surface is sought.

The selection of abrasive material is, aside from possible commercial considerations, almost entirely dependent upon the character of the material to be ground.

Wheels are made up in many combinations of grain sizes and a number of grades of hardness. In foundry practice it is found that grain sizes from 8 to 30 include practically all operations while the grades or relative hardnesses vary from P to U or W, with all the intermediate letters designating a certain grade. The alphabet is used to denote grade by employing the beginning of the alphabet to denote soft wheels.

Grain size is measured by the mesh of the screen or number of openings per linear inch over which the ground abrasive is sieved, while grade is a relative measure of hardness and represents the tenacity with which the bond holds the grain particles together. Thus, wheels are being made so soft as to enable one to rub the particles away quite readily with the fingers while others are made so hard that specially devised instruments and apparatus is necessary to true or size them.

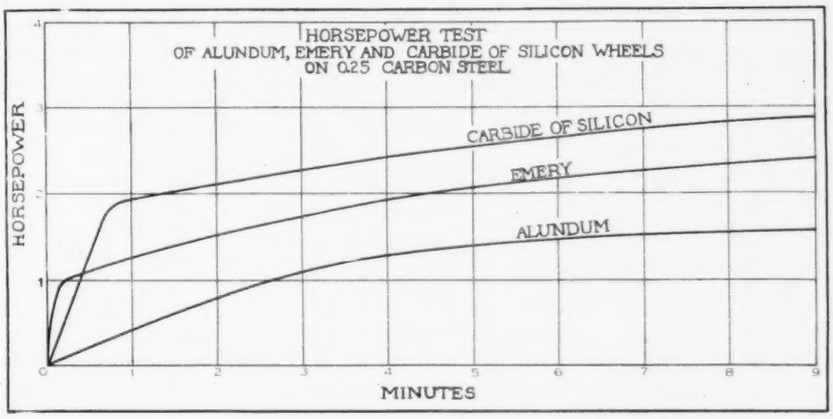

FIG. 1—HORSEPOWER TEST OF VARIOUS KINDS OF GRINDING WHEELS

Until a comparatively few years ago, little was known of different kinds of abrasives and still less of the characteristics of those most generally used, but greater accuracy together with more active competition and the lack of dependence that could be placed in natural products, either with respect to quantity or quality, made it necessary to seek a way out. The result is that today, by far the largest proportion of grinding wheels are made of artificial products which are controllable in quantity as well as quality.

We have come to recognize two principal groups of abrasive materials: (1) The aluminous group, which includes emery, corundum, alundum, aloxite and the like, and (2) the silicon carbide group, embracing crystolon, carborundum and similar products manufactured abroad.

The aluminous group is worthy of a little closer analysis. First, emery

Presented at the Chicago, 1914, convention of the American Foundrymen's Association.

was the base of all grinding wheels. It is a product mined in Greece and Turkey, but not stable as to quality nor quantity. It is impure, carrying a high iron oxide content and rarely exceeding 60 to 65 per cent in crystalline aluminum oxide. It was quickly recognized that aluminum oxide content in crystalline form represented a direct measure of abrasive qualities, and a consequent effort was made to find a purer product.

The discovery of India, Carolina and Canadian corundum seemed to fulfill all the hopes in this respect and the materials themselves actually proved their value over emery because of the higher purity, running from 85 to 90 per cent in alumina. The supply, however, was found to be limited and attention was turned to the possibility of an artificial product with the result, that alundum was discovered in 1900, and since then has made for itself an enviable record. Alundum is the result of the fusion and simultaneous purification in electric arc furnaces, of the mineral bauxite, a hydrated oxide of alumina, mined for this express purpose in Arkansas. It is purer than either emery or corundum, much more uniform, dependable as a source of abrasive supply and has characteristics which the natural products lack.

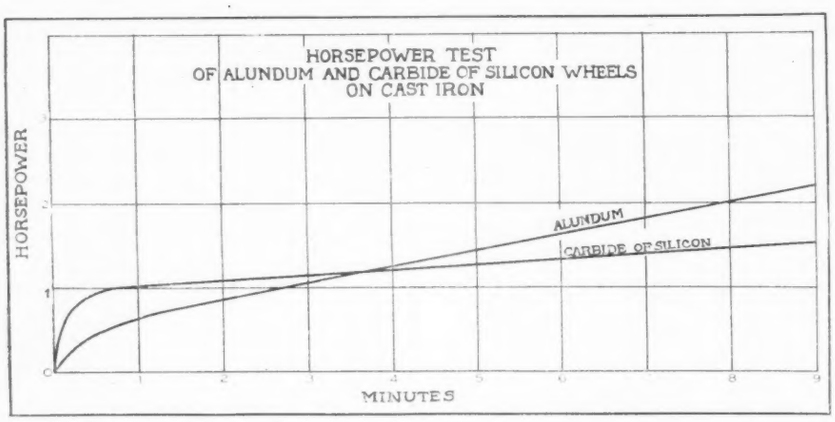

FIG. 2—HORSEPOWER TEST OF ALUNDUM AND CARBIDE OF SILICON WHEELS ON CAST IRON

Artificial, Aluminous Abrasives

One of the principal advantages is that the artificial, aluminous abrasives may, by certain treatments during the process of manufacture, be given varying physical characteristics, such as toughness or temper. Thus, alundum is made tough for certain purposes, while also a material of greater brittleness, white alundum, is manufactured for operations where the work of grinding is delicate and particularly sensitive, requiring something more mellow in its action than is needed for snagging castings. The silicon carbide group does not, among its members, show the wide differentials in quality that the aluminous group does, since the production of this material is wholly dependent upon artificial processes and it must be manufactured under similar conditions with consequently similar results; the variations in the final product are more dependent upon the skill and knowledge of the wheel maker than upon inherent differences in the quality of the silicon carbide material itself. This product is the result of electrically heat-treating proper admixtures of coke and sand principally. Its characteristics are extreme hardness, probably harder than alundum, more nearly approaching the diamond, and of relatively extreme brittleness, easily breaking under shock in contrast to alundum, which with great hardness combined the characteristics of toughness.

We have then to consider the abrasive materials themselves as classified and, from purely the academic side of the problem, the artificial products are being recognized more and more as superior to the natural.

The first thought that a general classification of abrasives might be established as a guide to proper selection dependent upon the kind of material ground was obtained from competitive trials. An assimilation of this fact, however, was slow in coming, partly because of a lack of complete understanding and partly because no one manufacturer had a variety of abrasives suited to the different classes of metals and the perhaps quite natural tendency to cling to the old thought that an abrasive is an abrasive, and if good for one material should be equally so for all.

Later investigation has proved otherwise and disabused the minds of those directly connected with this work that different materials may require a quite different kind of abrasive when low cost is a factor to be considered.

It has been found that on all classes of steel from the poorer to the highest grade alloy steels, the aluminous abrasive, alundum, was far superior to emery, corundum or carbide of silicon, while on materials of a less tough nature, such as cast or chilled iron, brass, bronze, etc., silicon-carbide gave the better results. This leads to a general classification of materials and prompts one to seek the particular characteristic common to all which, varying quantitatively, might be the key to an understanding.

All the factors were eliminated as not directly bearing on the subject except tensile strength. This one physical characteristic permits of a general classification from which certain tenable conclusions may be drawn; however, it must be said that this rule, like others, has its marked exceptions. Hence a series of investigations was made which appear decidedly enlightening and seem to explain some points that had, heretofore, become accepted facts, but only vaguely understood.

Results of Investigation

Fig. 1 shows curves developed from tests made on a motor-driven cylindrical grinding machine equipped with all the necessary instruments to give the minutest data relative to power, speed, etc. The test was made on 0.25 per cent carbon machinery steel. An analysis of these curves shows that alundum is the most efficient abrasive for this work. The reason for alundum showing a higher efficiency in point of power consumption than emery is due to its greater degree of purity, while the fact that carbide of silicon, the hardest and sharpest abrasive, falls below either of the aluminous abrasives, may not be so easily understood. This is because of its decidedly different physical characteristics, it being thought that because of its comparative brittleness, the grain will not penetrate a metal of high tensile strength, but will break off.

The emery wheel, being composed of a somewhat softer cutting material, on account of the impurities in the grain, also loses its cutting teeth when grinding this tough steel, although not as quickly as carbide of silicon.

Fig. 2 shows the relative efficiency of alundum and carbide of silicon on cast iron. Here the alundum wheel is superior to the carbide of silicon up to a certain period, but after passing this point the carbide of silicon becomes more effective. The explanation is that the carbide of silicon

grain is just tough enough to withstand the comparatively light work it has to do in cutting metals of low tensile strength. The grain of alundum, in this case, is perhaps a little too tough. It stands up until the grain is too dull, rubbing instead of cutting, requiring more power, and causing much heat which in turn converts the chips into globules.

Fig. 3 shows the relative efficiency of the abrasives in question and may be of assistance in determining the kind of abrasive to be used. It shows that carbide of silicon is most efficient on materials low in tensile strength, such as cast iron, phosphor bronze, brass, granite, etc., while alundum has its greatest efficiency on steel, malleable iron, etc.

The theory of classification on the basis of tensile strength seems well supported and the general similarity of the curves representing emery, corundum and alundum (ranged as one would expect them to be based upon their relative purities in aluminum oxide) is particularly noteworthy.

The entirely different characteristic of crystolon or silicon carbide is shown by the curve representing its work. At approximately 40,000 pounds tensile strength, the silicon carbide crosses the aluminous group curves. This corresponds with practical findings that on malleable iron it is often difficult if, indeed, not impossible to decide which is the better abrasive without a careful investigation being instituted. It is noteworthy also that on practically all materials other than metal, silicon carbide is the most effective; this includes granite, marble, concrete, horn, rubber, cork, leather, bone, pearl, etc.

A General Rule

In the selection of abrasive material for foundry snagging, therefore, a general guide (not infallible) may be found in the foregoing considerations. The selection of grain and grade is quite a different matter, however. We have to consider carefully that the life and productivity of a wheel made of a given abrasive material is directly measured by both the grain size and the strength with which the grains are held together. The latter factor is dependent upon the bond both in point of quantity and character.

The function of this bond is not only to hold the cutting particles of the wheel together and to give the wheel the proper factor of safety at the speed it is to be run, but it must also be possible to vary its strength to fit the work it is called upon to do. We often hear the operator say that the wheel is too hard or too soft. He means that the bond retains the cutting teeth so long that they become dulled, and this wheel is inefficient; or, in the case of a soft wheel, the bond is not strong enough to hold the cutting teeth and they are pulled out of the wheel before they have done the work expected.

The bond to be used for any given operation depends upon several factors:

1.—The wheel and work speeds should be considered, the latter in case the grinding is done by machine and not merely by hand application. The speed of the wheel has a most important bearing upon its action in point of hardness. A wheel traveling at 5,000 surface feet does not have the resistance that it would have if it were rotating at 6,000 surface feet, hence the consideration of the speed at which wheels are operated must of necessity influence the grade selection. The falling off in surface speed as the wheel wears down is also an important consideration and will be more fully touched upon.

If the work is mounted as in a cylindrical grinding machine or lathe or on the table of a boring mill, revolving against the cut of the wheel, the speed of the work obviously affects the lasting qualities of the wheel and generally it is a fact that as the higher the work speed, all other conditions being equal the harder must be the wheel.

2.—The condition of the machine, whether it be a floor stand, swing frame or flexible shaft machine, is important, since worn bearings, or an ill-fitting shaft, permit the wheel to jump and pound, thus breaking down the structure without effective work resulting. The rigidity of the machine has an equally important bearing since it is obvious that a light, springy structure may be as bad a wheel consumer as loose bearings in a massive construction.

3.—Contact is likewise a necessary consideration, since obviously sharp and narrow fins, sprues or gates have a natural dressing action and must be met with a correspondingly harder product, while if the contact is wide and comparatively smooth the wheel must be softer to permit of the cutting particles taking hold. If too hard a wheel under such conditions is used, it will soon be found that the cutting teeth get dull and glaze, the wheel requiring dressing which results, of course, in waste.

4. — The method of application, whether gentle or abusive, is a factor as well. In some cases heavy castings are swung against the wheel face with such force as to make the entire apparatus vibrate. Extremely hard wheels, under such conditions, are paramount, while with small, hand-applied castings, the gentler application requires a softer wheel to actually perform the work.

5.—The ability of the operator should be considered. Herein lies a very elusive factor, in that wherever the human element is introduced, variables must necessarily be concomitant therewith. It is not uncommon to find two operators, working side by side, under as nearly identical conditions as it is possible to produce, obtaining vastly different results in both output and life of the same grinding wheels, and they consistently continue to remain in the same relative positions unless the inferior worker is taught some of the very simple principles instinctively picked up by his neighbor.

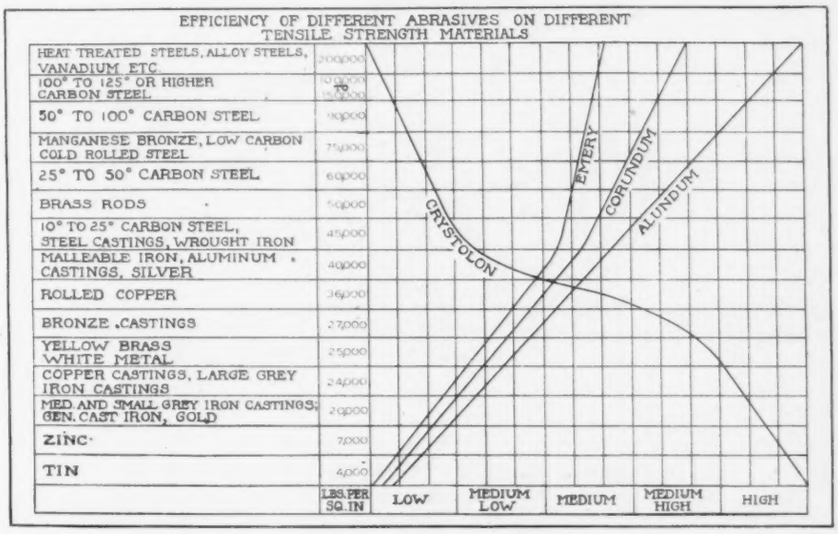

FIG. 3—EFFICIENCY OF VARIOUS ABRASIVES ON DIFFERENT MATERIALS

Application of Work to Wheel

The method of applying castings, so that by the very work the wheel is performing, it is kept sharp and free-cutting, is a matter to which every grinding room foreman should give attention. Permitting a wheel to become dull and, consequently, require dressing, is wasteful, both in that valuable wheel material is thrown away and the operator's time lost. If the casting is such that no matter how it is applied, frequent dressing must be resorted to, it is a reasonably safe assumption that the wheel is not the proper one for the job.

In many instances in the case of both large and small castings, it has by education been possible to entirely discard the dresser, resulting in greater production and longer life for a given wheel. In many kinds of grinding a certain reasonable amount of dressing

is necessary just as a milling cutter requires sharpening in machine work, but in snagging work a combination of grain and grade should be used that will permit of a sharp wheel face being maintained without recourse to the wasteful dressing tool.

6.—Character of material, whether hard or soft, tough or brittle, goes hand-in-hand with the question of contact and determines both the grain size as well as the grade. In some materials it is necessary to experiment with both kinds of abrasives before the best is determined, while with others it is practically a foregone conclusion which kind will prove best. Generally, brittleness in abrasive material does not go with high tensile strength and hard irons call usually for the silicon carbide, whereas tough materials require the aluminous abrasive. Hard materials, if contact is wide and little dressing action takes place, will be best served with a wheel of somewhat softer grade than is required for tough steels. The various factors already described must be considered collectively and no definite rules can be set down to adhere to.

7.—The finish desired is practically a measure of the grain size necessary. For rough, heavy castings, where the essential feature is to remove the stock in the shortest possible time, and finish is secondary, an aggregation of coarse grains, each plowing out a comparatively heavy chip, may be used, while on the other hand small castings such as many machine parts, ornamental fixtures, or parts that are to be plated, must be provided with a fairly smooth surface requiring, in turn, grains of finer mesh, down to 24, 30 or 36, each of which manifestly cuts less deep than a 10, 12 or 14-mesh grain, leaving consequently shallower furrows in the finished surface.

Grain Size

Sight must not be lost of the fact that grain size has a certain influence on the action of a wheel with respect to its hardness or wearing qualities. Because of this, certain differentiations may be employed to overcome possible difficulties, by altering the grain size without necessarily altering the grade. For example, a 16-grade U wheel may be found a little too hard. It is feasible and practical in many instances to then change to a 14-grade U, which gives the wheel a slightly more open structure and under the same conditions will be found to act a little softer. Thus frequently advantage is taken of this fact and judicious substitutions often assist in bettering the conditions.

Mention has already been made of the influence of speed on both the cutting action and life of a wheel. It is worthy of a little deeper consideration.

At times it is reported that a wheel is below some other wheel in point of output and life, when an investigation may show that comparison has been made between wheels of different diameters, and while the revolutions per minute may be alike the peripheral speed is quite different. A maintenance of proper speed means much to the productive capabilities of a wheel.

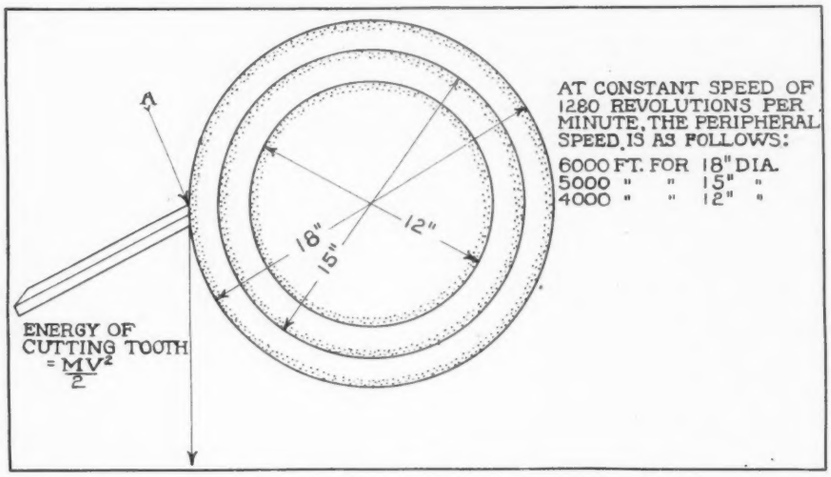
A
AT CONSTANT SPEED OF 1280 REVOLUTIONS PER MINUTE, THE PERIPHERAL SPEED IS AS FOLLOWS:
6000 FT. FOR 18" DIA.
5000 " " 15" "
4000 " " 12" "
18"
15"
12"
ENERGY OF CUTTING TOOTH = MV²/2

FIG. 4—DIAGRAM SHOWING VARIATIONS IN PERIPHERAL SPEED AND ENERGY

An 18-inch wheel at 1,280 revolutions per minute moves with a peripheral speed of 6,000 feet. At 15 inches in diameter and the same revolutions per minute the surface speed is about 5,000, while at 12 inches it has dropped to 4,000.

The peripheral velocity at all times varies directly as the diameter under constant speeds. That is, the velocity at which the face of the wheel travels, when the number of revolutions per minute remains constant, grows less as the diameter decreases; hence, when the wheel is only five-sixths of its original size, the surface speed will be only five-sixths of that when the wheel was mounted, and when the diameter is down to two-thirds the original, the velocity of the surface will also be but two-thirds of the original.

When a grinding wheel acts upon a piece of metal forced against its face, it is called upon to do work, or expend energy. This energy is supplied by the power given to the spindle and is taken up largely by the resistance the work offers to the abrasive particles acting as cutters on the face of the wheel. These particles cut loose a given piece of metal which leaves the point of contact at a line tangential to the wheel. At the same time, the resistance of the metal causes the abrasive particle to be worn down and broken off, or if the cutting edge of the particle in question has become very dull, the resistance of the metal may tear it out of its setting, exposing a fresh, sharp particle, which can do the work.

All this requires energy, which is stored in each particle of abrasive grain and capable of performing work. This energy factor is proportional to the square of the velocity with which the body travels, hence the power to do work falls off more rapidly than merely the difference between surface speeds at varying diameters. It is not so difficult then to understand why the complaint is frequently made that a wheel has diminished in productiveness toward the center and appears soft.

Consider Fig. 4. The cutting teeth when in contact with the work at *A* have a certain energy stored up in them, due to their mass and speed of travel. This energy is used in part to cut chips, and since this energy, as shown by the mathematical expression in the diagram, is proportional to the square of the velocity, it falls off as the diameters shrink to 15 and 12 inches in the proportions of 36 to 25 to 16. These latter figures represent the squares of the peripheral speed. In other words, when the diameter of the wheel has become 15 inches, the energy stored up in the cutting tooth is but 70 per cent of that at 18 inches, and when 12-inch diameter is reached, the energy is less than half of that at 18 inches, or only 44.5 per cent of the original.

The grain has therefore less energy stored up within itself with which to meet the same resistance and the particles lose in cutting quality and are more readily torn bodily out of their setting. The wheel, therefore, loses in productive power as the speed of its cutting tooth is reduced, acting softer and forming the basis of complaints because of a lack of appreciation on the part of the user of the importance of speed. The logical method of meeting this difficulty is either to steadily increase the speed of rotation as the diameter wears, or from time to time to transfer wheels

to machines running at higher speeds. It must not be assumed, however, that the productive capacity of a wheel when worn down to 12 inches will be the same as at 18 inches, even if the peripheral speed is maintained constant. Manifestly, each cutting particle is called upon to act as much oftener as the revolutions are increased as follows:

Diameter.	Surface feet.	R. P. M.
18	6,000	1,280
15	6,000	1,520
12	6,000	1,920

Hence the cutting tooth, when at 12-inch diameter, is called upon to perform nearly 55 per cent more cuts if no greater wear is had. It is not likely that the grain will stand up to this, but it will approach it and the greater holding power of the bond at the higher speed will hold even a comparatively dull grain with sufficient tenacity to plow out a chip which might otherwise be met by a resistance sufficient to tear out the grain and leave the partial work to be completed by the next grain in contact.

Life of Wheel and Speed

The relation of life of wheel to speed is perhaps more clearly indicated in Fig. 5, representing the results of some tests recently reported upon. These curves show the rate at which the life of the wheel decreases as the peripheral speed drops off. The continuous straight line is for a wheel lasting 150 hours in wearing uniformly from 18 to 9 inches in diameter. The surface speed to start was 5,400 feet and revolutions per minute being maintained constant the surface feet dropped to 2,700 feet at 9 inches diameter.

At 5,400 surface feet and full diameter the wheels start off at a 200 to 250-hour pace, but the effect of a falling off in speed is almost immediately detected and instead of obtaining even 200 hours of wheel life, the ultimate result is considerably less than 150. Had these wheels been speeded up again at 15-inch diameter and 12-inch, they undoubtedly would have shown more nearly straight lines and their life proportionately increased. The inclination of the lines to the horizontal measures directly the rapidity of wear and the more acute this angle, the more rapid the loss of wheel diameter.

Increased production is unquestionably to be expected from an increase in speed, because of, first, the greater energy and consequent cutting ability of the grain particles; second, the more frequent cuts of each grain per unit of time; and third, the harder action of the wheel, or better, the greater holding power of the bond.

It must be borne in mind, however, that a wheel selected to do a certain piece of work at say 5,000 initial surface feet, will not, if already at the limit of hardness, necessarily operate satisfactorily at 6,000 surface feet per minute. A change in grain and grade combination may be necessary and the higher speeds should be employed only when the machines are in good condition, and provided with proper protection hoods.

The results of these plottings clearly indicate that a wheel should, in so far as is practical, be maintained at a uniform surface speed, either by variable speed motor control, cone pulley shift, or as is now being done in many shops, transferring the wheel from one stand to another every two or three inches of its wear. Thus, periodically a higher number of revolutions are provided to bring the surface speed back to practically that at which the new wheel started. This will be found to bring about a condition of economy little appreciated by those who have not had occasion to try it.

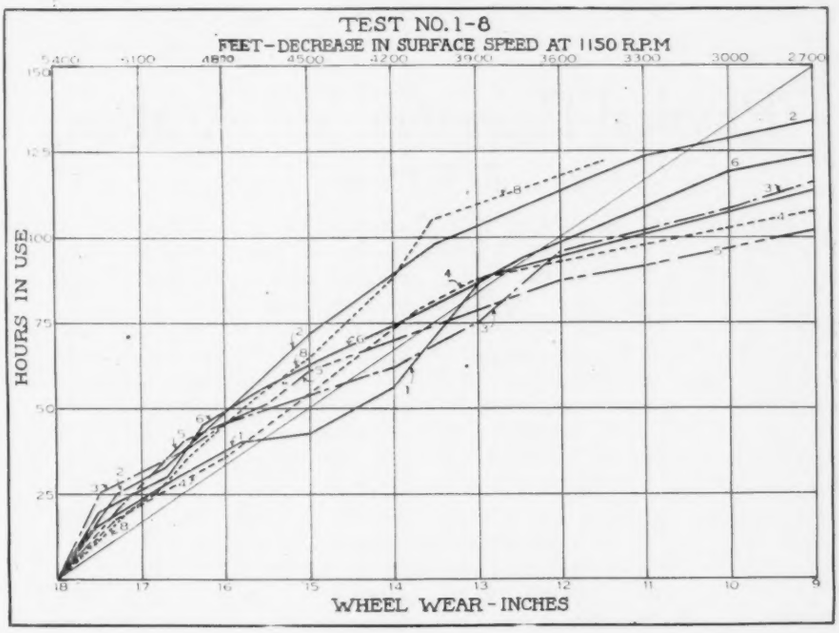

FIG. 5—WHEEL WEAR CURVES

Uses of Grinding Wheels

It would not be practicable to outline the many hundreds of operations for which grinding wheels are required, but the accompanying table may serve as a guide and has been prepared on the basis of wide general experience with wheels made of alundum and crystolon. Within the ranges given it is likely that a satisfactory combination of abrasive, grain and grade for any given grinding operations will be found.

From this table it will be noted that the aluminous abrasive is generally specified for the high tensile strength material while crystolon is set against the low. To this, however, as well as other rules, exceptions are to be recorded. For example, while malleable iron is given as an aluminous abrasive material, the unannealed product is generally found to be better served by the more brittle, silicon carbide abrasive. Aluminum is another curious exception, in that its peculiar physical characteristics make it necessary to have the interstitial space between the grains practically filled, as in an elastic wheel. Also the fact may be pointed out that both kinds of abrasives under discussion may be used. Fig. 3 shows the position of malleable iron and aluminum at about the crossing points of the efficiency curves, and only slight local conditions may influence the selection of abrasive in such a way that apparently the same general class of material in two plants is ground most effectively with crystolon in one and alundum in the other.

The measure of value of a wheel in any industry, especially where it constitutes an important tool in preparing the product for the market, is unfortunately, in many instances, not thoroughly appreciated. Wheel value rating based on life alone, that is the number of hours it is in service, is still frequently applied, but manifestly the true value of a wheel cannot be gaged by this factor alone with any degree of dependability. One wheel may last longer than another, but not turn out as much work per hour as will a freer cutting wheel of shorter

life, while at the same time total production may be the same. Obviously the wheel that has the more tonnage per unit of time to its credit must be the more economical of the two since the capacity per unit investment of wheel, machine and space is increased. Strange to say this fact is lost sight of frequently, but happily the operation of grinding wheels is commanding the more careful consideration that its importance in the industries warrants, and a better understanding of the relationships which output per unit of time, life and operator's wages bear to each other is gradually but surely being developed. Without a consideration of these three factors collectively, one cannot be certain that the best wheel is being employed.

TABLE SHOWING ABRASIVES ADAPTED TO DIFFERENT CLASSES OF WORK

Kind of Work.	Grain.	Abrasive.	Grade.
Large Steel Castings	10 to 14	Alun. Vit.	S and harder
Small Steel Castings	20 to 30	Alun. Vit.	P to S
Large Mall. Iron Castings	14 to 20	Alun. Vit.	Q to U
Small Mall. Iron Castings	20 to 30	Alun. Vit.	P to S
Large Cast Iron Castings	16 to 24	Crys. Vit.	O to U
Small Cast Iron Castings	24 to 36	Crys. Vit.	P to U
For Machining Alloy Steel Castings on Lathe, Boring Mill and Shaper Types of Machines	14 to 20	Alun. Vit.	M to Q
Brass and Bronze Castings	24 to 36	Crys. Vit.	O to Q
Aluminum Castings	30 to 36	Alun. } Crys. }	Elas. 4 to 5

Physical Properties Vs. Analysis

By W J Keep

Question: — On page 174 of "Cast Iron", by W. J. Keep, Table 72 gives three cases of the first and last iron of the same composition from the same heat. In each case the last iron is stronger and has a lower percentage of shrinkage than the first iron. The analysis of one of these heats shows for the last iron 0.04 per cent more total carbon, 0.15 per cent less combined carbon and 0.08 per cent less silicon than the first iron. In addition, the shrinkage per foot was 25 per cent less and the strength 7 per cent greater. I presume that the combined carbon was responsible for the variation in shrinkage and I would like to know why the combined carbon was less in the last iron.

Answer:—While the chemical composition will account for many peculiarities in cast iron, yet it hardly will account for the difference between the physical properties of the first iron melted in the cupola which has not become as hot as the last iron tapped. In the case referred to, the chemical compositions of the first and last iron were so nearly alike that they might almost be considered the same. The inference is that the increased temperature of the cupola at the close of the heat permitted more carbon to be retained, changed more of it to the graphitic form and burned up more of the silicon. In the presence of a high temperature, silicon changes combined carbon into graphitic and thereby decreases shrinkage and increases the strength of small castings. In this case there was a considerable decrease in sulphur and manganese.

The increased temperature alone can cause the decrease in these two elements by relative ratios, or at the high temperature they might unite and pass off into the slag. This, of course, also would change combined carbon into graphitic and would decrease shrinkage. The decrease of sulphur and manganese caused the other changes, both physical and chemical, yet it is more accurate to state that since the iron mixture was exactly the same throughout the heat and the only variable was the temperature that the changes were caused by the heat variations. In all matters pertaining to cast iron there are unexplainable variations. Only general tendencies are worthy of note. The difference in the point of view of the pure chemist and the physicist is that the chemist truly says that an increase or decrease of combined carbon accounts for variations in strength, shrinkage and character of grain, while the physicist goes a step farther back and looks for a reason for the change in the combined carbon, such as an increase in silicon or a change in temperature of the melting medium. However, there is no disagreement between them. The physical properties are not always what are expected from the combination of chemical elements because of unforeseen variations in heat treatment. To show this was the object in presenting the tests referred to, a more striking illustration is given at the top of page 174 of this same book. Twenty-eight pounds of iron were caught in a hot ladle and three test bars were poured. Forty-five seconds later another set of three bars was poured and 45 seconds after this another set of three was cast. The iron was stirred all the time between the pouring of these test bars. The strength of the first bars poured was 440 pounds and of the last 530 pounds. The deflection was 0.23 inch and 0.27 inch respectively, and the shrinkage 0.123 inch and 0.131 inch, respectively. The depth of chill was 0.05 inch and 0.02 inch for the first and last set of bars. An analysis of these bars proved that the chemical composition of all was the same, which indicates that physical treatment may exert more influence than chemical composition.

Malleable Iron Difficulties

By W. J. Keep

Question:—A firm submitted five samples of malleable iron which show defects. These were molded in different ways but notwithstanding the change in molding methods, the defects continued. Three of the machined samples were cast at one time from the same ladle, but notwithstanding this, there appeared to be a difference in the metal.

Answer:—The castings referred to are discs, 1¼ inches in diameter and ⅜ inch thick at the edges, hollowed out to a thickness of ⅛ inch at the bottom. From the bottom of this cup, in the inside cavity, there projects upward a spindle, ⅜ inch in diameter and 1¼ inch high. The machined specimens have the spindles turned down to ¼ inch diameter and the cup turned inside to a saucer shape, sharp at the edges. In this instance the spindle was broken off close to the bottom of the concave saucer. This is white heart iron and I do not see anything wrong with the metal. The pattern should have been made almost finish size and then by starting the milling tool at the top of the spindle it can be milled down to the bottom. This manufacturer is turning out the cup part and the spindle afterwards, beginning the cut at the bottom. There is little strength to the heart of malleable iron and the metal has its limitations.

We will presume that the metal is unsound at the bottom of the spindle, but making the pattern a little more than ¼ inch in diameter would make it sounder. If there still would be a tendency toward an open grain, a chill placed against the outside of the bottom would prevent this. We do not know what kind of metal this is, but an analysis will give you this information. The carbon should be maintained as low as possible and this probably is accomplished by using steel scrap. The silicon probably is about 0.80 per cent. It would do no harm in such light castings to increase it to 1.10 per cent. If the sulphur is above 0.05 per cent, you may be obliged to sell some of your scrap rather than to try to remelt it. In machining malleable castings do not get below the skin more than is necessary.

Departmental Co-Operation in Foundry Work

How the Casting Plant Can Aid the Sales Department, With a Reference to the Shop Store

IN OUTLINING suggestions for co-operation in foundry operations it seems logical to consider first improvements in molding methods, and then to define their application to the sales department. Restricting generalities I may say that, to a certain extent, we all operate in a rut, depending upon the customs of yesterday for the production of castings today, and it is exceedingly valuable to be occasionally jarred out of that rut and to be compelled to improve our methods and consequently those of our co-workers in the organization.

There are many capable producing heads who can, if they have time and opportunity, improve production by decreasing waste, wear and tear, through the development of the individuals under them by more direct personal contact.

When Edison says that genius is 2 per cent inspiration and 98 per cent perspiration, he must have had in mind the necessity for a possible 100 per cent effort in comparison with the 60 per cent result that frequently prevails.

Edison's suggestion might be well applied to the average foundry where there is wasted time and misdirected energy which, if properly applied, would increase production considerably. This waste effort is being properly directed by a number of foundries which are developing organization efficiency to a point where it commands the intelligence and loyalty of all employes in the plant.

This process of development applies as well to the sales as to the production department, in that the sales force frequently does not thoroughly cover its territory by an intelligent system of canvassing all possible customers.

Need of Independence

First, I believe in independence, and my definition of that term typifies the dignified development of ideals for the advancement of employes and the improvement of appliances, as compared with the rough lack of consideration for employes and the limited understanding of modern molding methods, too frequently found in the management of many of our plants. Undoubtedly, the foremen and superintendents of the latter type will soon pass into history. Business methods of today, born of keen competition, and developing a necessity for fineness in all departments, will supplant them with men of broader understanding, who are better able to interpret the ideas of the company in its effort for the advancement of all employes. And it frequently will be found that the dismissed superintendent is a mechanic, in the best sense of the word, possessing a comprehensive knowledge of molding, but believing that the maximum of casting production is only the individual capacity of the molder, equipped with limited devices, receiving the indifferent attention common to the past decades, and without the support of a cohesive, systematic organization.

Lack of Progress

As a matter of fact, the iron foundries of this country, particularly those classed as jobbers, have not progressed in proportion with other branches of the metal trades. One may say that we have succeeded in spite of ourselves. We have not, except in a few cases, developed in our force a clear understanding or appreciation of that misused word efficiency.

In some cases the manager of the foundry is at fault. He has not afforded his foreman and employes an opportunity to promote themselves for the simple reason that he has not promoted himself, by keeping abreast of improvements in foundry practice.

That particular plant, therefore, has suffered from a lack of collective efficiency of employes regardless of how energetic or capable specific individuals may have been. In common with a mistaken attitude of many manufacturers in all lines, this manager has attempted to develop his personal success rather than that of the organization which he leads.

Today, however, many of these men realize that team-work is the only kind that secures results, and that the organization, as a whole, must have all possible development in each department.

Managers are understanding, too, that foremen and sales representatives form an important board of advisers, and it is for them to demonstrate that the business of the year may be profitable. Each department head, and I include the salesmen in this class for the reason that each man has specific territory to cover, should be taught to have an understanding, not only of their particular duties, but of the value of common fairness as applied to each other.

A solution of this problem is occasional meetings where each man may be given an opportunity to offer for discussion suggestions that are for the betterment of the foundry, and through which a closer bond of interest and enthusiasm may be aroused.

Frequently economies may be effected and new plans suggested by which it is entirely possible to relieve the manager or superintendent of much of the overload of work, which frequently embarrasses him, and does not leave him free to devote his time and thought to the introduction and application of improved foundry devices.

Further, every man in the plant, from the core boy to the department head, must realize the importance of the thorough fulfilling of his part in the organization scheme. Unless those heads are directly interested in their work, and are willing to devote their best talents to its improvement, they should voluntarily step aside for someone else. If, through a rigid self-examination they cannot arrive at the point where they will undertake this personal development, sooner or later substitutions in their positions must be expected.

Foundry engineering is in a deserved ascendency, utilizing as it does the skill of the inventor coupled with corresponding development in the personnel and esprit du corps of the force, and recognizing the value of the results to be gained by a well-balanced policy of humanitarianism.

Comfort of Employes

Progress in the production of castings will be assisted by a careful analysis of the facilities offered for the health and comfort of the employes, and installation of reasonable conveniences beyond the necessary comforts should be effected, many of which may be a source of income rather than expense.

Regardless of factory laws, it is practical to install clean toilets, wash and locker rooms, thus furnishing the

From an address delivered by William H. Barr, president of the National Founders' Association, at the February meeting of the Pittsburgh Foundrymen's Association.

molder a place for the safe deposit of street clothes, and the opportunity, if he cares to avail himself of it, to clean up before going home. These suggestions, if carried out, will help to dignify the trade of molding and place it on a higher comparative plane, the direct benefits of which are obvious.

The Foundry Store

Again, the foundry or works store I enthusiastically endorse as being keenly appreciated by all employes. It has been found advisable to have for sale cigars and tobacco, cigarettes being barred, which if properly bought, are sold to employes at about 20 per cent less than prices asked by the corner saloon. Chocolates, candies and chewing gum also find ready sale at similar prices and the consumption per man will frequently average from 5 to 7 cents per day. The direct result is beneficial to the men, in that the candy supplies, in the best manner, some of the alcohol which the system requires, plus the excellent nourishing value of the chocolate. In plants where chocolates or chewing gum is available, drinking to excess has been checked, the men are healthier, the percentage of accidents has been decreased, the Monday morning grouch is minimized, and a lower percentage of loss in bad castings has been maintained.

Also, the sale of bottled milk of good quality at moderate prices has proven popular and healthful, has still further reduced liquor consumption and another advanced step has been taken in the development of shop morale.

Cakes, coffee and even supplies such as foundry shoes, leggings, goggles, etc., are sold for the convenience and economy of employes.

Further, a proper understanding and adoption of safety devices, even to minor details, convinces the molder that the employer has his interest at heart, and he responds in like proportion by harmonious efforts, rather than by antagonistic criticism, and a further increase in production is thereby effected.

Here I must emphasize the direct financial gain resulting to both molder and founder by a business-like elimination of the extreme disorder which so frequently prevails in foundries, and especially in the jobbing shop. It is not an extravagance to state that an increased output of from 10 to 20 per cent can be obtained if flasks and appliances of all kinds are available in an orderly fashion. Every time a molder starts on a still hunt for a proper clamp, chain or gagger, perhaps hurdling one or two piles of old sand or bottom boards en route, so much skilled effort has been lost. Naturally, too, the molder who works in an untidy plant is apt to be careless in his work. Conversely, the molder who works in a neat, orderly plant, where passage-ways are free, and his needs quickly supplied, always produces a higher order of work, more of it, and is much more anxious to remain permanently in his position. One capable laborer will keep a foundry in order and the effect on production is magical.

And, it is well to consider methods best suited for increasing the earning capacity of our molders. Why should we object to paying the very highest wage to a skilled mechanic if he, in turn, is giving a corresponding increase of output, and to that extent reducing the percentage of overhead chargeable to his floor.

If the molder is supported in his laudable desire to give increased comforts to his family, he is a better asset to his employer in his attitude toward shop discipline, as well as in his earning capacity, then should we not assist him by insuring proper ventilation, installing air vibrators, riddles, blow-offs as well as other minor modern conveniences.

It is important to have patterns and core boxes systematically cared for and repaired by a man whose sole duty it is to do this, and who also can correctly put in the hands of the molder all the matches and equipment that goes with the pattern and job, again economizing the time of the direct producer.

Training Apprentices

One failing of the average foreman is the lack of interest in the development of intelligent boys into skilled mechanics. While the molding machine and its operator are of undoubted value, we must see to it that we educate young men to enlarge our force. Otherwise, we shall have no solution of the problem of securing capable molders either in time of labor strife or of unusual prosperity.

In approaching the subject of teamwork with the marketing force, emphasis should be laid on a number of points:

When developing the sales department, care should be exercised in choosing the type of man necessary to succeed in the foundry business. Many managers are apt to put inexperienced foundrymen on the road, even though possessing possible sales merit, because, from a salary viewpoint, they seem to be economical.

If force of circumstances compels the engagement of such a man, before he is assigned to a territory, care should be taken to give him a general course of instructions, which will at least cover the rough details of the business. His personality should do the rest.

It is admittedly preferable, if possible, to send out as sales representatives, men who have had a foundry training, and this could more frequently be done if managers would encourage foundry employes who show natural sales ability, to eventually become members of the sales force.

Qualifications of Salesmen

Any man having the proper qualifications would work unceasingly to adapt himself to this changed and conditional opportunity, and his training would enable him to advise his customer in a practical way of results that could be secured through a proper application of such advice.

In every case, the salesman, as well as the department head, should be a man who takes care of his health, saves his money, avoids dissipation, handles his work systematically and satisfactorily, never putting off the work which is expected of him, and who, therefore, is ready for any emergency.

He should be an optimist filled with enthusiasm about his goods, and the standing of his company, and with the determination to see that the foundry properly carries out those details which he has promised to his customer.

With optimism he will hold the confidence of his trade, and usually have a reserve force that enables him to hold on until the conclusion of the sale.

The salesman should cultivate and study the methods of the successful salesmen with whom he is competing, for there is always, one big reason why a particularly successful man has placed himself in the top notch. And finally, he should be willing to admit possible error and to correct misunderstandings when they occur, in a straightforward manner, that will rebound to the reputation of the company he represents.

The management must be in position to offer to the salesmen exact knowledge of actual costs, in order to place him in the best position for meeting competition. Too frequently, in jobbing shops, the cost is arrived at from the average tonnage, regardless of the fact that large castings may cost less than 2 cents to produce, and without realizing that small castings worth anywhere from 5 to 10 cents per pounds are cutting down

the earnings of the more desirable grades of castings.

Again, quality too frequently is considered to be of minor importance in comparison with the tonnage, and many castings are shipped which should be scrapped after more careful inspection, rather than put the customer to the expense and inconvenience of returning them. Where careless deliveries of this kind are permitted your salesmen once again are at an extreme disadvantage, and an opportunity is given the purchaser to make justifiable complaints, which he will use as a leverage in attempting to secure lower prices.

If the managers are as progressive as they should be in the ideal foundry, salesmen will be permitted to spend the necessary time in the foundry in conference with department heads, acquiring knowledge which may be of immense value.

Foremen also should not forget that salesmanship is in itself a profession, and that if willing support and cordial co-operation is given to the salesmen, the common good of all will be directly benefited.

Further, it is the foremen's duty to point out to the sales force the bad points in jobs upon which they are estimating, urge specific recommendations for the construction of patterns, and in general equip representatives as completely as possible for the successful handling of work upon which depends so largely the prosperity of the company.

In addition, the salesman should have the information necessary to supply full data as to the requirements of customers, to try and arrange deliveries for the convenience of his foundry, to keep in touch with the improvements developed by competitors, and in every way suggest to the production department anything that will help them create sound economies and improve their output.

I thoroughly believe in the enthusiastic support of the sales and production heads, which is fostered by the management of many of our leading industries. Frequent meetings where everything in relation to the plant is discussed from manufacturing to advertising and financing, gives these employes a sense of partnership which is invaluable, particularly when it is necessary for the salesmen to defend their firm with customers who are dissatisfied and when the company's methods must be justified.

Salesmen also should have complete daily information of everything which pertains to their particular districts or territories; copies of orders, invoices, inquiries and correspondence should be daily referred to them, in order that nothing in their territories may happen without their knowledge.

And the production department should be in a position to offer comprehensive information as to its final costs as compared with original estimates, etc., for their guidance in future sales. Without this complete support, which I have suggested, a salesman frequently falls a victim to the capable purchasing agent only through lack of knowledge which should have been furnished to him.

REVOLVING SLAG CRANE

Revolving Crane For Handling Slag

An interesting revolving crane for handling cupola slab has been installed by the Dickson Car Wheel Co. in its plant at Houston, Texas. The principal features of the device are shown in the accompanying illustration. The crane consists of 16 radial arms fastened at the center to an upright piece of heavy pipe which rotates on easy turning bearings at the top and bottom. The radial arms are made of I-beams braced by diagonal rods, as shown in the illustration. A cast iron pot or ladle is hung on each arm. The arms are so arranged that each ladle swings in turn under the end of the cupola spout where it receives its load of molten slag.

Any iron which may run out with the slag sinks to the bottom of the ladle, even though two taps are made before the pot is filled. The iron forms a solid mass in the bottom and is easily separated from the slag when the pot is dumped. The slag itself is said to be solid and clean and to contain no particles of iron. By the use of this device it is believed an absolutely iron-free slag is secured. The slag is dumped from the pots into a small car, as shown in the illustration.

The crane turns easily and is operated by the cupola tender during the heat. He pulls the pots into position as they are required. A small air hoist is utilized to assist in dumping the pots. The crane is said to save considerable labor in handling slag.

Temperature of Cupola

By W. J. Keep

Question:—In one heat taken off recently the first iron contained 2.04 per cent silicon and the shrinkage was 0.155 inch, while the last iron contained silicon, 1.89 per cent, and the shrinkage was 0.162 inch. How do you explain this difference?

Answer:—The silicon content always is less at the last of the heat owing to the fact that the cupola is hotter. The shrinkage generally is much less at the end because high temperature makes the silicon more effective. The last iron is better in every way and therefore it is advisable to use the first iron for work that is not very particular. However, to improve the quality of the first iron, start the fire two hours before the iron is tapped, which will insure hot iron from the start.

The Salem Iron Foundry, Inc., Salem, Mass., has secured a site off Broadway near Rose street in South Salem and is building a plant.

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Trade Outlook

TRADE conditions in the foundry industry are displaying slow, but steady improvement and reflect the healthier status of business that has prevailed since the first of the year. Although the melt continues considerably below normal, the output of shops engaged in all lines of work shows an increase over the closing months of last year. Railroad buying, however, is conspicuous by its absence and until car orders are placed and repairs to rolling stock are made, foundry output will increase at a comparatively slow pace. There is an awakening in the demand for foundry equipment, particularly molding machines, and it is evident that producers of castings are meeting the prevailing low prices with a proportionate decrease in the cost of manufacture. Shops located in machine tool centers are operating on machinery work to meet the requirements of tool builders who have large orders for machinery for shipment to the nations at war. Foundries specializing in automobile work reflect the activity of the motor car industry. Quotations for No. 2 foundry grades in the leading centers follow: Pittsburgh, $13.70; Chicago local, $13; Buffalo, $13; 2X Philadelphia, $14.25; Birmingham, $9.50, and 2X Virginia, $12.50. Malleable iron is held at $13.70, Pittsburgh, and $13, Buffalo and Chicago, respectively. Standard low-phosphorus iron is quoted at $20.70, Pittsburgh, and $19, Philadelphia, while basic is unchanged at $13.20, Pittsburgh, and $13.50, eastern Pennsylvania.

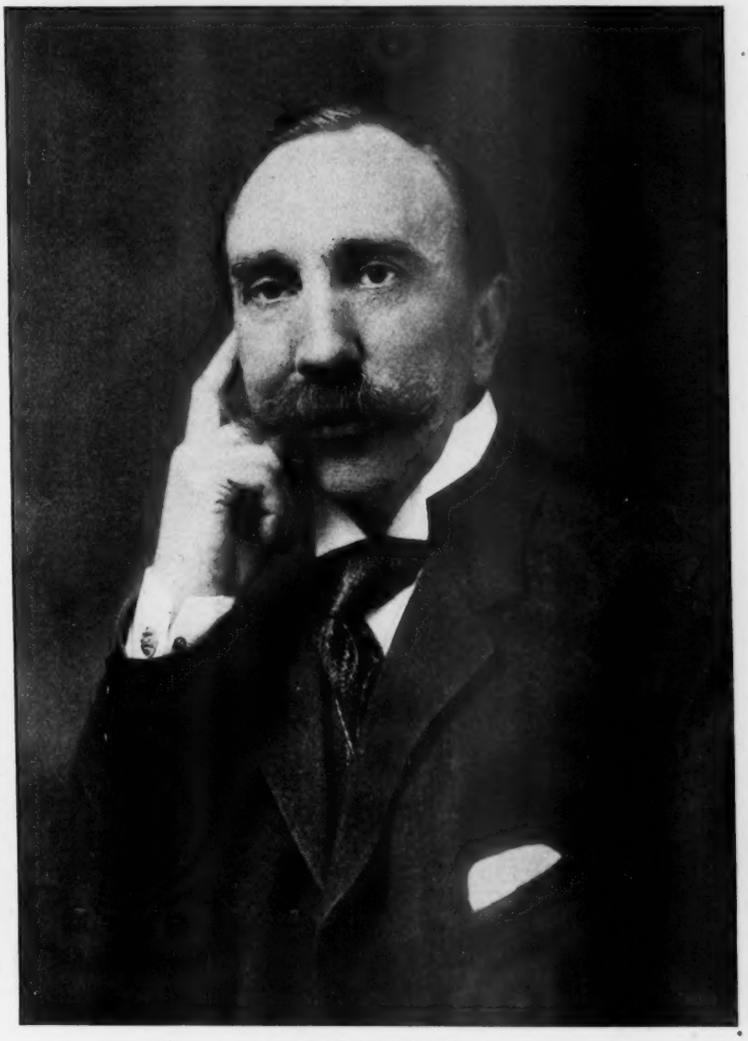
Extended Credits vs. Forced Discounts

IN THE February issue of *The Foundry*, page 76, editorial reference was made to a new method of financing pig iron advocated by Isaac F. Marcosson, in an article in the Jan. 7 issue of *The Iron Trade Review*. It was proposed that pig iron producers and consumers take advantage of the new currency law providing for the discount of acceptances by the federal reserve banks. H. D. Murphy, of Jersey City, N. J., takes exception to the method proposed and points out, in the following, that this is not a new idea:

> The editorial reference in the last issue of *The Foundry* to Isaac F. Marcosson's article, wherein he advocates that foundrymen take advantage of the new currency law and discount acceptances, overlooks the fact that this is not a new idea.
>
> Every little while letters float in to us from certain banking houses offering to buy our open accounts. Of course, the details are not the same as in the handling of acceptances, but both methods mean sacrificing a goodly proportion of a profit which is not any too large. Competition with foundries which take work at ruinously low prices because of erroneous cost systems, or worse still, no system at all, compels even the most wide-awake foundryman to make quotations which leave but little margin for discounting. Everyone concludes that the oftener money is turned over the smaller the profit that is necessary with each turn. Therefore, the customer would pay more uniform and, at the same time, lower prices for his castings if he co-operated with the foundry to the extent of making payment as promptly after delivery as possible. There appears no just reason why the manufacturer should make the owner of the foundry wait until the castings are machined, marketed and paid for, more than the dealer should defer payment until the manufactured articles are sold and paid for. Yet Mr. Marcosson evidently suggests that the foundryman either carry his customer for 60 to 90 days, or sacrifice some of his profit by discounting an acceptance covering the same period. If it is necessary to devise some scheme for extending credit still further than is the practice at present, let it not be at the expense of the foundry.

Death of Lydell Whitehead

Lydell Whitehead, president of the Whitehead Bros. Co., Providence, R. I., died at his home in New York City, Feb. 4, aged 59 years. Mr. Whitehead was the son of James Whitehead, who, with his brothers, was one of the pioneers in the development of the New York and New Jersey molding sand and clay trade. Lydell Whitehead devoted his entire life to the selection and production of foundry materials and had a wide acquaintance throughout the foundry industry. For a period of 42 years he was associated with the business acquired by the Whitehead companies and was instrumental in the incorporation of the present company in 1892. Since that time he has been president and one of the active managers of the business and its growth and success, to a large extent, can be attributed to his excellent judgment. He is survived by his widow, daughter and son, William Whitehead 2d, who is connected with the Whitehead company.



LYDELL WHITEHEAD

Personal

A. S. Baldwin has resigned as manager of the Best Mfg. Co., Pittsburgh, effective not later than April 1. This company recently was absorbed by the Kennedy-Stroh Corporation. Mr. Baldwin for two years was superintendent of the American & British Mfg. Co., Bridgeport, Conn. For four and a half years he was general superintendent of the Driggs-Seabury Ordnance Corporation, Sharon, Pa., and for three years general manager of the Alberger Pump & Condenser Co., Newburgh, N. Y.

B. S. McConnell has been placed in charge of the Cleveland office of the Ayer & Lord Tie Co., Chicago, located at 801 Swetland building, succeeding F. A. Weaver, resigned. R. W. Slaney succeeds Mr. McConnell in the Chicago territory.

Edward Maher's Sons, Newark, N. J., contemplate the equipment of a machine shop as an addition to their gray iron foundry to facilitate handling certain large machinery contracts of firms in the metropolitan district. John D. Miller has been appointed general manager and will take charge immediately. Mr. Miller formerly was affiliated with the Wheeling Mold & Foundry Co., Wheeling, W. Va.

Wm. H. Hulick, of New York City, has been re-elected president and treasurer of the Warren Foundry & Machine Co., Phillipsburg, N. J. A. D. Chidsey was made vice president.

Book Review

The Manufacture of Iron and Steel, German, ninth edition, 426 pages, published by the Verein deutscher, Eisenhuttenleute, Dusseldorf, Germany, and furnished by THE FOUNDRY for $1.50, postpaid.

This work, which now is in its ninth edition, has been almost completely revised to bring to date the discussions of the various iron and steel manufacturing processes, etc. The first chapter is devoted to iron ore, coal and coke and the operation of the blast furnace, while in the second chapter the manufacture of wrought iron, steel, etc., is considered. One complete chapter is devoted to iron and steel castings and the testing of iron and steel likewise is considered at length. The second part of this work is devoted largely to statistical features of the world's iron and steel trade and contains considerable valuable data regarding the distribution of iron ore and the production of iron and steel products by all the civilized nations. The German tariff on iron and steel products also is included.

A feature of this work is a complete directory by companies and products, of the blast furnaces, steel works and iron and steel foundries in Germany. This directory covers 80 pages and is the most complete of its kind available.

Eye Accidents

In a recent report of the industrial commission of Wisconsin, it is shown that over 70 per cent of all the injuries to workmen caused by chips, nails and other small objects, affect the eyes. Out of a total of 346 cases reported, 32 men lost the sight of one of their eyes entirely, 217 had eyes injured, 75 suffered from lacerations, seven from impaired sight and 15 from bruises. The causes of these injuries were as follows: 283 were hit by chips, 14 by nails, four by stone from blasts, three by bursting water glasses and 42 by other small objects.

The industrial commission further states in its report that of the 70 per cent it is safe to say that fully three-fourths of these eye injuries could have been avoided by the wearing of goggles.

In fact, within the past year many manufacturing plants in Wisconsin have adopted the use of goggles, and as a result eye injuries to the employes have been almost entirely eliminated.

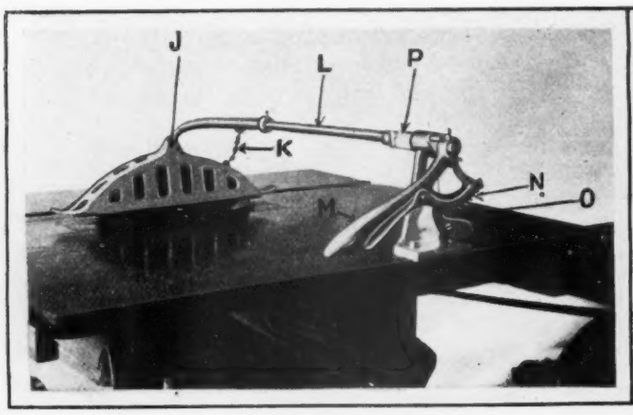


FIG. 1—SAW GUARD IN OPERATION

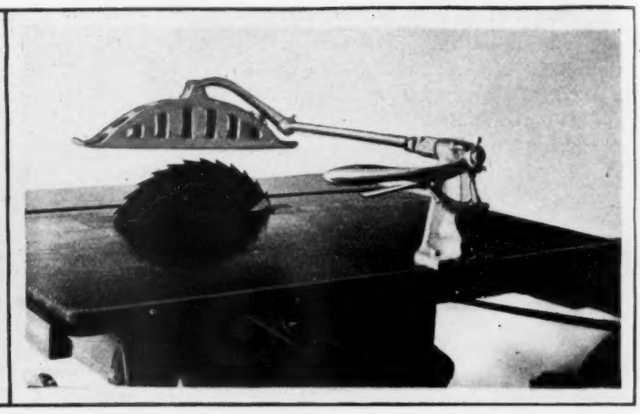


FIG. 2—ADJUSTABLE GUARD PARTIALLY RAISED

Adjustable Saw Guard

The adjustable safety saw guard shown in Figs. 1 to 3, was invented by Hobart W. Curtis, foreman of the patternshop of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Fig. 1 shows the position of the guard during the sawing operation. The guard partially raised is shown in Fig. 2.

The guard swings on a pivot *J* and is prevented from hitting the saw by the chain *K*. The horizontal shaft *L* carries on its end an arm for supporting the saw guard. It is controlled by the handle *M* which is equipped with a segment ratchet *N* and pawl *O* for locating the guard at the desired height. The

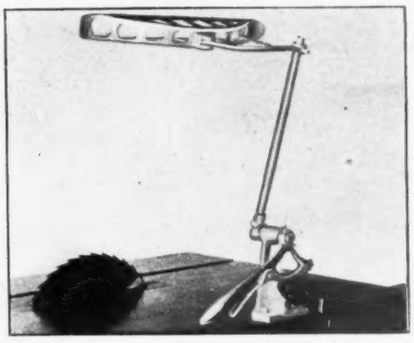


FIG. 3—GUARD SWUNG BACK

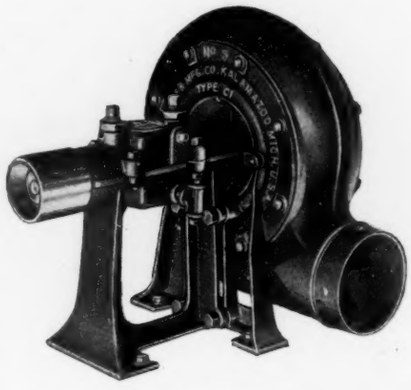
horizontal shaft has a joint, *P*, so that when the guard is not in use, it is swung back as shown in Fig. 3. The guard is made of aluminum and the working parts of steel and iron. It is very easily and quickly adjusted.

The Steel Casting Business

"The steel casting business," it is stated by G. Muntz, vice president and general manager of the Tropenas Converter Co., New York, "is undergoing a considerable change at the present time, due mostly to the fact that foundrymen are beginning to realize that steel castings might be made cheaper and better if a little more careful consideration was given to the special requirements of the user. The old school of steel foundrymen is gradually dying out and is being replaced by men who, through superior technical training, are in a position to explain the reasons for metallurgical phenomena. The old school did not try to explain, but simply endeavored to compare each particular case to some other that had previously been encountered. This is why we witness in the better steel foundries the installation of laboratories and the employment of metallurgists who are able to turn out steel castings as they should be made."

Volume Blower and Exhauster

In the accompanying illustration is shown a volume blower and exhauster manufactured by the Clarage Fan Co., Kalamazoo, Mich., which may be employed either as a single inlet exhaust fan or as a double inlet blower. As a single inlet exhaust fan it may be used for removing smoke, gases and fumes from foundries, over furnaces or in plating departments, where it may be used for conveying light materials such as removing dust from emery wheels or tumbling barrels. As a double inlet blower this fan will furnish the blast for operating cupolas. These fans are built in four sizes, namely, Nos. 5, 6, 7 and 9 and the number in each case is the same as the diameter in inches of the suction or outlet connections. All sizes are built reversible and adjustable. The side plates of the fan are removable and fit on either side of the casing, so that the fan may be either right or left hand, as desired. These plates are larger than the fan wheel, so that if it is desired to remove the wheel, this can be done by removing the eight cap screws and withdrawing the wheel from the case. The exhauster plates for blocking-off the inlet on the pulley side when the fan is used as a single inlet exhauster, are made in two parts, so that they can be removed or replaced without removing the wheel or disturbing the housing. The wheel is of the open type, making it suitable for all kinds of work, as it will not become clogged with dust from buffing wheels. The bearings consist of two sets of babbitted sleeves, each set being held in a ball and socket type of support consisting of a conical projection in the lower part of the case and an adjusting plug with a similar conical surface in the upper part of the case. A lock nut holds the plug in position after it is properly set. The two sets of sleeves are



CLARAGE VOLUME BLOWER AND EXHAUSTER

enclosed in one large outer case provided with felt washers at either end to keep out the dust and to prevent the oil from leaking out or being drawn out by the fan suction. The collar, which is fastened to the fan shafts between the sleeves, serves also as an oil rim and supplies an ample amount of oil at all speeds. Both the upper and lower parts of the outer case have large reservoirs, so that the fan requires little attention whether it is inverted or in its regular position. The only change necessary when it is desired to invert the fan is in the positions of the oil supply pipe and the plug.

Meeting of Testing Materials Society

The 18th annual meeting of the American Society for Testing Materials will be held at Atlantic City, N. J., June 22-26, with headquarters at the Hotel Traymore. A straw vote of the members of the society is being taken to ascertain whether it is desirable to continue or to abrogate the letter ballot of the membership at large as the final step in the procedure governing the adoption of standards. The executive committee is desirous of making recommendations on this important question in its next annual report and Secretary Marburg was instructed to ascertain the sentiment among the members through a straw vote by letter ballot.

Wall Type Radial Drill

A radial drill and reamer of the wall type is being built by the Vulcan Engineering Sales Co., Chicago, to meet the requirements of bridge, structural, boiler, car and railroad shops, ship yards and other plants where large surface areas are to be covered for drilling, reaming or countersinking. As shown in the accompanying illustration, the machine can be bolted to a building column or to the wall, or it can be carried on a truck or car, thereby making it portable. The latter is an exceedingly valuable adaptation in any shop where long lines of holes are to be drilled or reamed, such as bridge girders, hulls, boiler sections, etc. A stud is furnished in the boom end of the casting to provide a means for anchoring the boom to the floor when drilling holes of large diameter.

Power is obtained through coupling a countershaft, either belt or gear-driven, to the upper horizontal friction clutch shaft. The wall plate is a heavy casting provided with machined ways to guide the elevating carriage, which in turn supports the boom and sway bars. This carriage has large, bronze-bushed lugs through which passes the vertical shaft. Cupped brass frictions engaging with spur gears operate the screw shaft for raising and lowering the carriage. The spindle carriage is a heavy, ribbed casting supported on truck wheels. Provision is made for locking the carriage in position when drilling and reaming, and it is arranged to take the direct thrust of the spindle. The spindle carriage is assembled with ball bearings for end thrusts, in a large and substantial sleeve having a ground fit to the bore of the carriage frame. A large bevel gear guides and drives the upper end of the spindle. The power feed consists of four changes of gears in connection with the worm gear and friction clutch device. The hand feed is direct and is operated by the large hand wheel, which also constitutes the quick return when the power feed is disengaged. A counterweight automatically raises the spindle on the release of the hand feed. The horizontal carriage travel is 10 feet 9 inches and the vertical travel of the boom, 3 feet 6 inches.

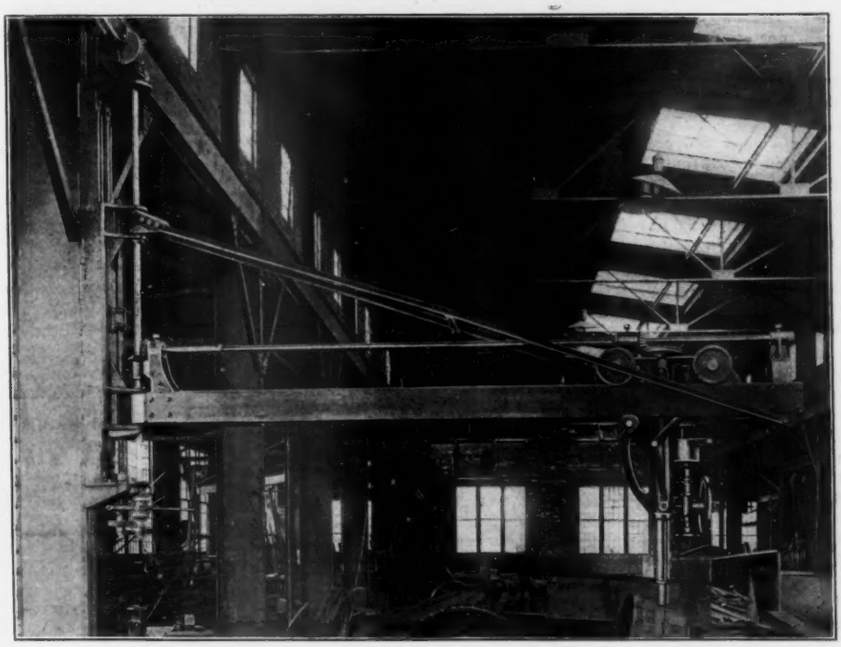
Crocker Bros., 30 East Forty-second street, New York City, have arranged with Woods, Huddart & Gunn, San Francisco, to handle exclusively and to distribute the pig iron, ferro-alloys and coke sold by Crocker Bros.

Death of Adam W. Bair

Adam W. Bair, during the past 35 years superintendent of the wheel foundry operated by the Chicago, Milwaukee & St. Paul railroad at Milwaukee, died in that city Feb. 10. As a wheel foundryman, Mr. Bair established an enviable reputation and the Milwaukee shop was one of the largest railroad foundries in the country.

Record Crane Delivery

A record for prompt shipment recently was made by the Whiting Foundry Equipment Co., Harvey, Ill., on an order for a three-motor electric traveling crane, 10 tons capacity and 30-foot span. The order was received by telegraph on Jan. 23, specifying delivery of crane complete on the purchaser's runway at New Bridge, Del., Feb. 10, 1915. Drawings were made, the crane constructed and it was shipped Jan. 29. The crane arrived at New Bridge, Feb. 4, and was ready for service Feb. 6, four days ahead of the specified time.



RADIAL DRILL AND REAMER OF THE WALL TYPE

British Foundrymen Abandon Convention

One of the results of the European war will be the omission of the annual convention of the British Foundrymen's Association, which was to have been held at Leeds, Eng., in May. At a recent meeting of the council of the society this action was taken.

The industries at Leeds, at this time, are unusually busy on war material and the fact that so many of the leading citizens who would have taken part in arranging the entertainment are either in military service or are undergoing training, makes it practically impossible for the foundrymen to hold the annual meeting in that city.

The firm name of the Metallurgic Engineering Co., 53 West Jackson boulevard, Chicago, manufacturer of electric furnaces for steel works and foundries, has been changed to the Snyder Electric Furnace Co., which more clearly describes the business in which the company is engaged. No change has been made in the personnel of the company and the officers continue as follows: President, Frederick T. Snyder; vice president, C. H. Booth; secretary, W. K. Booth, and treasurer, F. E. Berggren.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

J. N. Brownlee, Shubuta, Miss., will equip a foundry and machine shop.

Moorehead & Earehart, Portsmouth, O., have established a foundry and machine shop at 1233 Ninth street.

The Maiwurm German Aluminum Co., Ashland, O., manufacturer of aluminum kitchen utensils, has been succeeded by the German Aluminum Co.

The Bathurst Stove Co., Kansas City, Mo., has been incorporated with $12,000 capital to operate a stove foundry. The incorporators are M. G. Reed, T. T. Bathurst and others.

The plant of the bankrupt Central Foundry Co., Muskegon, Mich., has been purchased by S. P. Bacon, Cincinnati, who intends to keep it in operation.

The Flood City Mfg Co., Johnstown, Pa, has increased the capacity of its brass foundry by the installation of four melting furnaces.

The Ziegler Stove Co., Wichita Falls, Tex., has been incorporated with a capital stock of $25,000. The company will erect a stove foundry.

The Standard Plating & Brass Foundry, Anderson, Ind., has been incorporated with a capital stock of $5,000 by G. A. Robinson, O. H. Furr and A. H. Gillispie.

The Schuylkill Haven Foundry & Iron Works, Schuylkill Haven, Pa., has been sold to a syndicate of capitalists headed by J. L. Adams, of Reading. Some important improvements are contemplated.

The name of the Pontiac Motor Castings Co., Pontiac, Mich., has been changed to the Pontiac Motor Castings & Mfg. Co. and the capital has been increased from $15,000 to $35,000.

The General Brake Shoe & Foundry Co., Chicago, will establish a branch in Memphis, Tenn., under the name of the Memphis Brake Shoe & Foundry Co. The plant of the Allen Engineering Co. has been leased and will be equipped for general foundry work and brake shoe manufacturing.

The Andrews Engineering Co., 647 Peoples Gas building, Chicago, has been incorporated with $10,000 capital to engage in the manufacture of bridge operating machinery, iron and steel castings, etc. J. B. Strauss, Wesley W. Hawley and Martin Andrews are the incorporators.

The plant operated by Aluminum Castings, Ltd., Ottawa, Ont., has been purchased by the Ontario Specialties, Ltd. This company will specialize in the manufacture of brass, bronze and aluminum castings and particular attention will be given to the requirements of manufacturers demanding a special alloy subject to severe tests and unusual conditions.

The Enterprise Aluminum Co., Massillon, O., recently organized to manufacture aluminum cooking utensils, has temporarily established its foundry in one of the buildings of the Massillon Rolling Mill Co. The company is planning to equip a modern plant of its own. R. E. Bebb is president and general manager and Blaine Zuver, treasurer.

The Magnus Co., Inc., Manhattan, New York, has been incorporated with $3,000,000 capital to engage in the manufacture of all kinds of metal castings, car and locomotive brasses, journal bearings, etc., for railways, steamships, etc., and general line of railway equipment and supplies. H. S. Ogden, J. M. Ferry and G. H. Makepeace are the incorporators.

New Construction

The Kennedy Foundry Co., Baltimore, Md., will erect additions to its plant.

Thomas L. Conlong, Myrtle street, Bloomfield, N. J., will erect a foundry.

The Lebanon Steel Foundry, Lebanon, Pa., will erect an electric steel plant.

Plans are being prepared for a brick foundry building, 90 x 150 feet, for the Wilmington Casting Co., Wilmington, O.

A contract has been let for a 50 x 95-foot foundry for the Salem Foundry Co., Salem, Mass.

S. B. Patch & Son, Streator, Ill., will build a 36 x 147-foot, brick and steel addition to their foundry and machine shop.

The Howe Scale Co., Rutland, Vt., has awarded the contract for a brick and steel foundry, 120 x 288 feet.

The Bierman-Everett Foundry Co., Irvington, N. J., will erect a foundry, 60 x 200 feet, on Glorieux street.

A contract has been awarded for the erection of a 30 x 160-foot addition to the plant of the Interstate Foundry Co., Cleveland.

The Wheeler Foundry Co., Worcester, Mass., contemplates the erection of a plant in the spring.

The Pierce, Butler & Pierce Mfg. Corp., Syracuse, has awarded the contract for a 2-story pattern shop, foundry and warehouse, 40 x 68 feet.

Plans have been prepared for the erection of a 1 and 2-story, fireproof building for the Robins & Myers Co., Springfield, O. The 2-story section will be 100 x 100 feet and the foundry 60 x 275 feet.

C. H. Kellerman will erect a foundry and machine shop at 461 West Erie street, Chicago, at a cost of $52,000. Hermon Freddl is the architect.

A contract has been awarded for the erection of a 2-story reinforced concrete addition to the plant of the Doehler Die Casting Co., Brooklyn, N. Y.

The United States Cast Iron Pipe & Foundry Co., Bessemer, Ala., will erect a steel and concrete addition at a cost of $50,000.

The Peninsular Stove Co., Detroit, will construct a $225,000 addition to its present buildings. This improvement will give the company 2,275,000 square feet of floor space.

The Zimmerman Steel Co., Lone Tree, Ia., has purchased a site of 10 acres at Davenport, Ia., for the erection of a new plant, and when this is completed the Lone Tree works will be removed to the new site. A large foundry and machine shop will be erected.

Plans which are now being prepared for additions to the plant of the W. O. Hickok Mfg. Co., Harrisburg, Pa., include a main shop, one and two stories, 150 x 263 feet; foundry building, 60 x 140 feet; heating plant, six dry kilns and stable of brick, concrete and steel construction.

The board of governors of the Loyal Order of Moose has appropriated $350,000 for a machine shop, foundry and printing plant. Plans for the building will be received in May. J. J. Davis and M. M. Garland, of Pittsburgh, and J. J. Lentz, Columbus, O., are members of the board.

NEW TRADE PUBLICATIONS

TUMBLING MILLS AND BRASS FOUNDRY EQUIPMENT.—Two catalogs, recently issued by the Whiting Foundry Equipment Co., Harvey, Ill., are devoted respectively to tumbling mills and brass foundry equipment. The tumbling mill catalog consists of 16 pages and shows a variety of tumblers adapted for various foundry uses. Numerous installations also are illustrated and wet tumblers for brass work and cinder mills also are shown and described. The brass foundry equipment catalog contains eight pages and is devoted largely to coke-fired furnaces of the pit type. Crucible tongs, shanks, etc., also are shown.

STORAGE BATTERY EQUIPMENT. — A 32-page bulletin issued by the Atlas Car & Mfg. Co., Cleveland, is devoted to its line of storage battery locomotives, cranes and cars. The locomotives are made in varying types from 2½ to 8 tons capacity with both single and double-end control. One storage battery locomotive shown is designed especially for moving rolling stock. A number of different types of storage battery trucks also are illustrated, which can be used to advantage for pulling loads in all industrial plants. An interesting storage battery crane truck is shown, as well as a storage battery locomotive crane and storage battery cars. The bulletin is well-illustrated throughout.

BRASS FOUNDRY EQUIPMENT.—The extensive line of brass foundry equipment manufactured and sold by Frederic B. Stevens, Detroit, is illustrated and described in a 48-page bulletin recently issued. Natural draft, coke-fired furnaces are shown, as well as those employing gas or oil for fuel. In addition, all of the necessary equipment for the brass foundry is illustrated, including brass furnace lining blocks, crucible shanks and tongs, cabbage pot, core ovens of various types, tumbling barrels, polishing machines, crushers and pulverizers, rosin mill, sand sifters, magnetic separators, sprue cutters, band saw, molders' benches, snap flasks, mold jackets, wire brushes, vibrators, etc. The bulletin is unusually well-illustrated and contains a complete exposition of most all the equipment required by the brass foundry.